FINAL

Corrective Action Plan for the Risk-Based Closure of Building 4522

Seymour Johnson Air Force Base
North Carolina

Prepared For

Air Force Center for Environmental Excellence
Technology Transfer Division
Brooks Air Force Base, Texas

and

4 CES/CEV
Seymour Johnson Air Force Base
North Carolina

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FINAL

CORRECTIVE ACTION PLAN FOR THE RISK-BASED CLOSURE OF BUILDING 4522 SEYMOUR JOHNSON AIR FORCE BASE, NORTH CAROLINA

AETC Contract No. F41689-96-D-0710
Order No. 5015

Prepared for
AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
TECHNOLOGY TRANSFER DIVISION
BROOKS AIR FORCE BASE, TEXAS

and

4 CES/CEV
SEYMOUR JOHNSON AIR FORCE BASE, NORTH CAROLINA

July 1999

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ACRONYMS AND ABBREVIATIONS

μg/L	micrograms per liter
4CES	4th Civil Engineering Squadron
AETC	Air Education and Training Command
AFB	Air Force Base
AFCEE/ERT	Air Force Center for Environmental Excellence, Technology Transfer Division
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
°C	degrees centigrade
CAP	Corrective Action Plan
CDLE	Colorado Department of Labor and Employment
CH_4	methane
CO_2	carbon dioxide
COPC	chemicals of potential concern
CSA	comprehensive site assessment
CSM	conceptual site model
DEHNR	Department of Environment, Health, and Natural Resources
DO	dissolved oxygen
EDB	ethylene dibromide
EPH	extractable petroleum hydrocarbons
°F	degrees Fahrenheit
Fe2+	ferrous iron
Fe3+	ferric iron
ft/day	feet per day
ft/ft	feet per foot
ft/yr	feet per year
GCLs	gross contaminant levels
HASP	health and safety plan
HDPE	high-density polyethylene
LLNL	Lawrence Livermore National Laboratories
LNAPL	light, non-aqueous phase liquid
LTM	long-term monitoring
MDL	method detection limit
mg/L	milligrams per liter
ml	milliliter
MP	monitoring point
MS/MSD	matrix spike / matrix spike duplicate
msl	mean sea level
MTBE	methyl tert-butyl ether
mV	millivolt
MW	monitoring well
N	nitrogen
NCAC	North Carolina Administrative Code

ORP	oxidation/reduction potential
OSHA	Occupational Safety and Health Administration
PAH	polynuclear aromatic hydrocarbon
Parsons ES	Parsons Engineering Science, Inc.
PEL	permissible exposure limits
PID	photoionization detector
ppmv	parts per million, volume per volume
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
RNA	remediation by natural attenuation
SAP	sampling and analysis plan
SAR	soil assessment report
SB	soil boring
SSTLs	site-specific target levels
SU	standard unit
SVE	soil vapor extraction
SVOCs	semivolatile organic compounds
TCLs	target cleanup levels
TMBs	trimethylbenzenes
TOC	total organic carbon
TPH	total petroleum hydrocarbons
TVH	total volatile hydrocarbons
TWA-TLV	time-weighted average-threshold limit value
USACE	US Army Corps of Engineers
USEPA	United States Environmental Protection Agency
UST	underground storage tank
VOCs	volatile organic compounds
VPH	volatile petroleum hydrocarbons

SECTION 1

INTRODUCTION

Parsons Engineering Science, Inc. (Parsons ES) was retained by the Air Force Center for Environmental Excellence, Technology Transfer Division (AFCEE/ERT) under Air Education and Training Command (AETC) Contract No. F41689-96-D-0710, Order No. 5015 to prepare a corrective action plan (CAP) to support a risk-based remediation decision for contaminated soil and groundwater at the Building 4522 site at Seymour Johnson Air Force Base (AFB) in North Carolina.

1.1 DESCRIPTION OF THE RISK-BASED APPROACH

The objective of risk-based remediation is to reduce the risk of specific chemicals to human health and/or ecological receptors such as animals or plant life. For any chemical to pose a risk, four elements must exist at the site:

- A source of chemical contamination that exceeds or could generate chemical contamination above health-protective or aesthetic standards;
- A mechanism of contaminant release;
- A human or ecological receptor available for chemical contact; and
- A completed pathway through which that receptor will contact the chemical.

If any one of these four elements is absent at a site, there is no current risk. The reduction or elimination of risk can be accomplished by limiting or removing any one of these four elements from the site.

The goal of this risk-based remediation approach is to find the most cost-effective method of reducing present and future risk by combining three risk reduction techniques:

- Chemical Source Reduction - Achieved by natural attenuation processes over time or by engineered removals such as free product recovery, soil vapor extraction (SVE), or *in situ* bioventing.
- Chemical Migration Control - Examples include natural attenuation of a groundwater plume, and SVE to prevent migration of hazardous vapors to a receptor exposure point.
- Receptor Restriction - Examples include land use controls and site fencing to eliminate chemical exposure until natural attenuation and/or engineered

remediation reduce the chemical source and/or eliminate the potential for chemical migration to an exposure point.

1.2 RISK-BASED APPROACH TASKS

The major tasks of this risk-based project are:

- Assessing available data and collecting any supplemental site characterization data necessary to define the nature, magnitude, and extent of soil, soil gas, surface water and groundwater contamination and to document to what degree natural attenuation processes are operating at the site;
- Determining whether an unacceptable risk to human health or the environment currently exists or may exist in the foreseeable future using reasonable exposure scenarios, quantitative contaminant fate and transport models, and exposure concentration estimates;
- Evaluating and recommending a remedial alternative that both reduces the source of contamination and minimizes or eliminates risks to potential receptors; and
- Documenting the remedial action selection process in a report that satisfies North Carolina Department of Environment, Health and Natural Resources (DEHNR) requirements.

All work was performed in accordance with guidance and requirements contained in the project Sampling and Analysis Plan (SAP) and Health and Safety Plan (HASP) (Parsons ES, 1997a and 1997b).

1.3 REGULATORY REQUIREMENTS

This section describes the approach developed by the North Carolina Department of Environment, Health, and Natural Resources (DEHNR) for risk-based remedial action at sites contaminated with petroleum products. The *Groundwater Section Guidelines for the Investigation and Remediation of Soil and Groundwater,* Volume II, Petroleum Underground Storage Tanks (USTs) (North Carolina DEHNR, 1998a) and the North Carolina Administrative Code (NCAC), Title 15A, Department of Environmental and Natural Resources, Division of Water Quality, Subchapter 2L, Classifications and Water Quality Standards and Risk-Based Assessment and Corrective Action for Petroleum USTs (15A NCAC 2L) present guidance for determination of soil and groundwater remedial requirements for closure of petroleum-contaminated UST-related sites. It is assumed that the UST regulations are applicable to this site because the jet fuel pipeline was the source of the contamination and is connected to a UST system.

The *Proposed Risk-Based Assessment and Corrective Action Rules for Petroleum Underground Storage Tanks* (North Carolina DEHNR, 1998b) describes which sites are covered by the rule. Existing discharges or releases can be covered by the rule if site assessment has not been completed, or if application of the rule will be more cost effective, or more protective to human health or the environment. Because additional site characterization has recently been performed for the Building 4522 site, it is assumed that the new risk-based rules are applicable for this site.

1.3.1 Risk Classification

This subsection details the North Carolina DEHNR's (1998b) classification process that determines the risk posed by a discharge or a release. If the criteria for more than one risk category apply, the discharge or release will be classified as the highest applicable risk classification.

High Risk

- Water supply well contaminated,
- Water supply well threatened,
- Groundwater has potential future use as water supply,
- Explosion or fire hazard present, or
- Release poses imminent danger to human health or the environment.

Intermediate Risk

- Surface water threatened,
- Deeper aquifer that is or may be used as a drinking water supply is threatened,
- Wellhead protection area affected, or
- Gross levels of contamination are present.

Low Risk

- Not classified as high or intermediate risk, or
- Based on site-specific information, the North Carolina DEHNR determines that the discharge or release poses no significant risk to human health or the environment. The Base is currently actively recovering free product in well MW1S, which is the only well that contains free product.

If free product is present, the risk level of the site is automatically classified as being at least intermediate. A letter from North Carolina DEHNR dated 25 November 1997, states that the site at Building 4522 had been tentatively classified as a Class CDE (low-risk) site (Appendix B). However, this classification must be reconsidered as of 1 January 1998. Based on the fact that all recoverable free product is being extracted from the subsurface at the Building 4522 site, the risk level of the site is assumed to be transitioning from intermediate to low, because none of the other intermediate risk conditions are fulfilled. In addition, the results of the fuel weathering study performed at the site (Section 2.1) indicate that substantial weathering-related reductions in the toxicity of the free product at the site have occurred over time (and continue to occur).

1.3.2 Groundwater Assessment and Cleanup

Groundwater compliance requirements associated with UST releases must comply with the cleanup levels established for the appropriate risk category. The following summarizes the guidance for discharges or releases reported on or after January 2, 1998 for each of the three risk categories (North Carolina DEHNR, 1998a). As described in Section 1.2, preexisting discharges or releases also may follow this guidance if site assessment has not been completed or if application of the risk-based rules will be more cost effective or more protective to human health or the environment.

For a high-risk discharge or release, the responsible party must perform a CSA and submit a report documenting the results. If the North Carolina DEHNR cannot reclassify the discharge or release as low risk following the receipt of the CSA report, a CAP must be submitted. A CAP must propose appropriate remediation strategies to restore groundwater quality to the level of the standards established in 15A NCAC 2L .0202. In any CAP, natural attenuation must be considered as a remedial option and used to the maximum extent possible. Prior to site closure, the responsible party must submit a Site Closure Report, demonstrating that contamination has been remediated to the applicable cleanup levels.

The process for intermediate risk discharges or releases is the same as described above for high risk sites; however, the CAP must propose to remediate contaminated groundwater to a level sufficient to protect surface water, wellhead protection areas, and deeper Coastal Plain aquifers that are or could be used as a source for drinking water. At a minimum, contaminated groundwater must be remediated to the gross contaminant levels (GCLs) established in 15A NCAC 2L .0115(d)(2)(D).

For a low risk discharge or release, the North Carolina DEHNR will notify the responsible party pursuant to 15A NCAC 2L .0115(h) that no further action is required. However, prior to issuing this notification, the responsible party must demonstrate that soil contamination has been cleaned up to the lowest applicable levels. No further groundwater assessment or cleanup is required.

1.3.3 Soil Assessment and Cleanup

Soil cleanup requirements associated with UST releases must comply with the cleanup levels established for the appropriate risk category. The following summarizes the guidance for discharges or releases reported on or after January 2, 1998, for each of the three risk categories (North Carolina DEHNR, 1998a).

For high and intermediate risk releases, the responsible party must document the vertical and horizontal extent of soil contamination. The soil assessment information should be incorporated into a CSA report, and the report also should include a proposal for remediating soil contamination. Prior to site closure, the responsible party must demonstrate that soil contamination has been cleaned up to applicable cleanup levels. This information should be included in a site closure report. Soil contamination at high or intermediate risk sites must be remediated to the lowest of:

1. Residential or Industrial/Commercial maximum soil contaminant concentrations, whichever is applicable; or

2. Soil-to-groundwater maximum soil contaminant concentrations.

If the risk classification of a discharge or release is downgraded to low following the submittal of the CSA report, a soil cleanup plan must be submitted to address remediation of soil contamination, rather than a comprehensive CAP.

For low risk releases, a responsible party must submit a Soil Assessment Report (SAR), documenting the vertical and horizontal extent of soil contamination. Soil contamination must be remediated to the residential or industrial/commercial maximum contaminant concentrations, whichever is applicable. The plan for remediating soil contamination should be incorporated into the SAR. Prior to closure, a responsible party must submit a soil cleanup report with a site closure request documenting that soil has been remediated to applicable cleanup levels and requesting that the North Carolina DEHNR issue a notice of no further action.

1.4 REPORT ORGANIZATION

This CAP consists of 8 sections, including this introduction, and 7 appendices. Site background, including operating history and a review of environmental site investigations conducted to date, is provided in the remainder of this section. Section 2 summarizes the 1998 site characterization activities performed by Parsons ES. Physical characteristics of the site and surrounding area are described in Section 3. A Tier 1 evaluation is completed in Section 4 to identify those site contaminants that are considered chemicals of potential concern (COPCs). Section 5 summarizes the nature and extent of COPC contamination at the site. Section 6 addresses the effects of natural chemical attenuation processes that are documented to be occurring at the site, and presents chemical fate and transport and receptor exposure analyses. Section 7 presents the Tier 2 risk evaluation along with the summary and conclusions of this evaluation of risk-based remediation at the site. Section 8 presents references used in preparing this CAP.

Analytical data sheets and chain-of-custody records are in Appendix A. Pertinent information from prior investigations is presented in Appendix B. Boring logs, groundwater sampling forms, and well construction diagrams for all drilling and sampling activities completed by Parsons ES during the December 1998 field effort are included in Appendix C. Appendix D includes the input and output from the aquifer slug test analyses. Appendix E includes the supporting documentation for the quantitative calculations used in the predictive chemical fate assessment and computation of Tier 2 site-specific target levels (SSTLs). Appendix F includes BIOSCREEN model input and output. Appendix G contains the data quality assessment report.

1.5 SITE DESCRIPTION AND BACKGROUND

Seymour Johnson AFB is located in the city of Goldsboro in Wayne County, North Carolina (Figure 1.1). Seymour Johnson AFB was activated in 1942 and remained active until 1946. Following Base closure, the property was deeded to the city of Goldsboro in 1949. From 1950 to 1953, the Base was used as a commercial airport by Piedmont

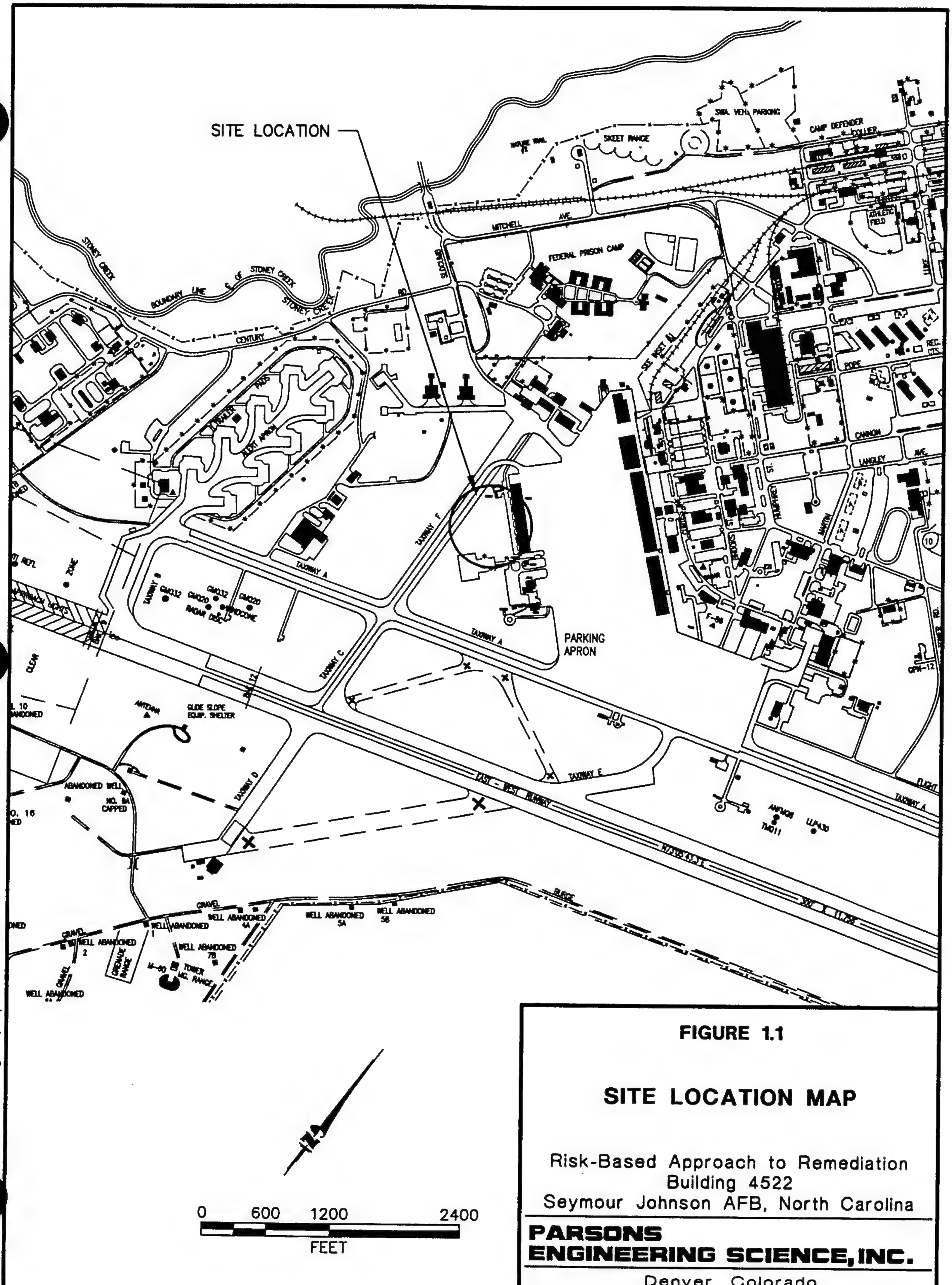

FIGURE 1.1

SITE LOCATION MAP

Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina

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Airlines. Portions of the Base also were used for warehouse storage and other miscellaneous functions. Base ownership was transferred back to the Department of Defense in 1952.

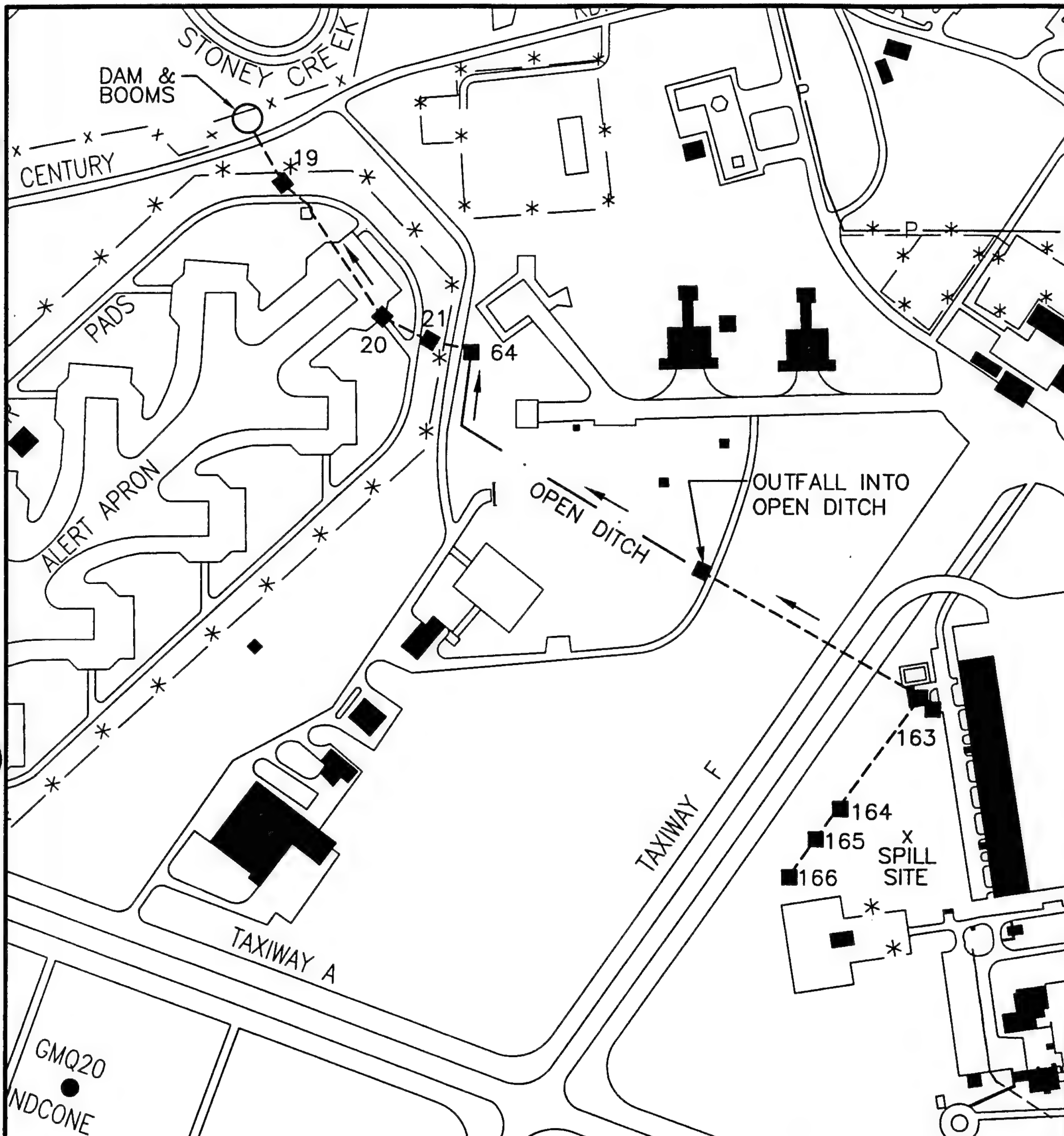
On December 14, 1995, the Seymour Johnson AFB Fire Department responded to a release of JP-8 aviation fuel between an aircraft taxiway and Building 4522. Base Civil Engineering Operations and Environmental flights were notified concerning the release. The release occurred in a valve pit located approximately 130 feet west of Building 4522 and has been attributed to an ineffective "O"-ring seated in a flexible coupling. The failed "O"-ring was replaced to prevent further fuel loss. By the time the fire department responded to the release, the pit was flooded with fuel and had overflowed onto a 90-foot by 35-foot area of grass surrounding the pit.

As part of abatement measures, a trench was dug between the valve pit and a storm water drain located about 90 feet west of the valve pit. The trench was used as a sump, and Base Logistics Group Fuel Management personnel pumped approximately 2,200 gallons of JP-8 from the trench.

Fuel also was released into a storm water drain. The drain flows into an open ditch and then into a buried conduit which eventually discharges into Stoney Creek (Figure 1.2). The ditch was inspected following the release by Base personnel, and was found to have signs of fuel contamination. Booms were placed in the ditch to retain any additional contamination, and a dam was constructed at the outfall into Stoney Creek. Booms were also placed both upstream and downstream of the dam. About 100 gallons of fuel were recovered from water ponded at the dam. Based on the preliminary findings presented by the 4th Civil Engineering Squadron (4 CES) at Seymour Johnson AFB, the North Carolina DEHNR requested that an assessment be conducted at the site to determine the vertical and horizontal extent of groundwater and soil contamination.

On January 18, 1996, Contractors and Engineers Services, Inc. of Goldsboro, NC installed a shallow monitoring well (MW) to determine if groundwater at the site had been impacted. A temporary MW was placed in the vicinity of the release to a depth of eight feet below ground surface (bgs) and sampled. The groundwater sample was analyzed for purgeable halocarbons [US Environmental Protection Agency (USEPA) Method 601], purgeable aromatics (USEPA Method 602) and lead (Method 3030C). A soil sample also was collected at a depth of 5.5 feet bgs and analyzed for total gasoline-range petroleum hydrocarbons using USEPA Method SW5030/8015M. Results of this testing were forwarded to North Carolina DEHNR for their review.

In April 1996, Parsons ES (1996) performed a CSA to determine the extent of soil and groundwater contamination resulting from the fuel release. As part of the site assessment, Parsons ES performed soil sampling in the vicinity of the release and at the boreholes being advanced for monitoring well placement (Figure 1.3). Soil samples were analyzed for total gasoline and diesel/kerosene-range organics using USEPA Methods SW5030/8015M and SW3550/8015M, respectively. Six groundwater MWs (MW1, MW1D, and MW2 through MW-5) were installed by Parsons ES in April 1996, and groundwater samples were collected from the new wells following completion and development. Samples were analyzed for extractable lead (Method 3030C), volatile



LEGEND

BURIED STORM WATER DRAINAGE LINE AND PATH.

OPEN STORM WATER DRAINAGE LINE DITCH AND PATH.

■166 STORM WATER DRAIN ENTRY POINTS.

0 200 400
FEET

FIGURE 1.2

SURFACE WATER FLOW FROM BUILDING 4522

Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina

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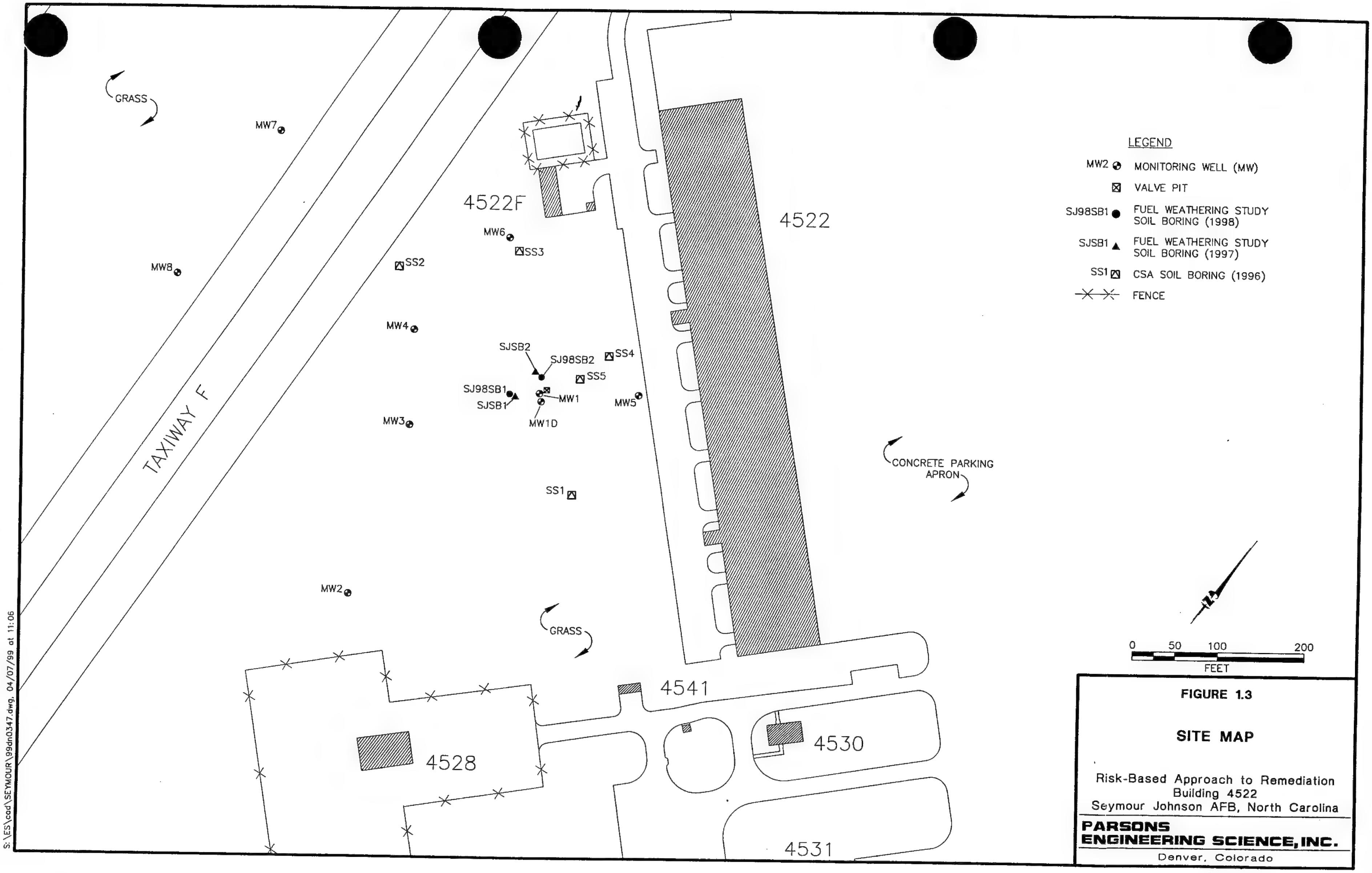

FIGURE 1.3

SITE MAP

Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina

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organic compounds (VOCs) (USEPA Methods 601 and 602), and semivolatile organic compounds (SVOCs) (USEPA Method 625).

Further site assessment activities were completed in July 1996, when the US Army Corps of Engineers (USACE), Kansas City District, installed and sampled three additional MWs (MW-6, MW-7, and MW-8) to more fully delineate the hydrocarbon plume in groundwater (Figure 1.3). Groundwater samples were analyzed for VOCs using USEPA Method 8021.

In May 1997 and March 1998, Parsons ES conducted a fuel weathering study of the free product that is present on the groundwater surface at Building 4522. Soil and groundwater samples also were collected for laboratory analysis during this study. The results of this study are described in Parsons ES (1999). On May 14 and 15, 1997, two soil and two groundwater samples were collected near well MW1S for laboratory analysis. Two free product samples also were collected from MW1S for laboratory analysis. All samples were analyzed for benzene, toluene, ethylbenzene, and xylenes (BTEX) (USEPA Method 8020), trimethylbenzenes (TMBs), naphthalenes, and methylnaphthalenes. Soil samples also were analyzed for total fuel carbon (total petroleum hydrocarbons), and the density of product samples was measured. On March 10, 1998, three soil samples and one groundwater sample were collected near MW1S for laboratory analysis. Two free product samples also were collected near and from MW1S for laboratory analysis. Sample analyses were identical to those performed on the May 1997 samples, with the addition of total fuel carbon analysis for groundwater samples.

The results of the fuel weathering study indicated that the total BTEX content of the free product was decreasing at first order rates of 26 to 36 percent per year over a 2.25-year period. Compound-specific reduction rates were highest for benzene, followed by toluene, xylenes, and ethylbenzene (Section 6.3.3 and Appendix B).

SECTION 2

SITE CHARACTERIZATION ACTIVITIES

Several soil and groundwater investigations have been conducted at Building 4522. These investigations focused on characterizing and delineating dissolved hydrocarbons in groundwater and residual fuel hydrocarbons in soil. Parsons ES conducted a supplemental investigation at the site during December 1998 to collect site-specific data relevant to quantifying the effects of natural contaminant attenuation processes and to facilitate development and implementation of a risk-based remedial action for the site. Soil gas, soil, surface water, and groundwater were sampled to:

- Further delineate the extent of contamination;
- Assess temporal trends in soil and groundwater contaminant concentrations;
- Support contaminant fate and transport analyses; and
- Develop appropriate exposure-point concentrations to compare to final remediation goals.

Data collected during previous investigations were used to augment this study. Emphasis was placed on collecting data documenting the natural biodegradation and attenuation of fuel hydrocarbons in soil and groundwater at the site.

The December 1998 supplemental site characterization activities performed by Parsons ES are briefly described in the remainder of this section. Most site characterization procedures (i.e., soil, soil gas, surface water, and groundwater sampling procedures) are described in detail in the project SAP (Parsons ES, 1997a).

2.1 SCOPE OF DATA COLLECTION ACTIVITIES

As part of the risk-based remedial approach for the site, field data collection efforts focused on investigating specific chemical constituents that potentially pose a threat to human health or the environment. The chemicals targeted for study at this site were identified from previous site investigations and the chemical composition of the primary contaminant source (i.e., release of JP-8 from a transmission pipeline).

The risk-based investigation for the site was conducted according to the methodologies presented in the *Work Plan for the Risk-Based Investigation and Closure of Building 4522* (Parsons ES, 1998), hereafter referred to as the work plan. The work plan was developed according to available guidelines and requirements of the North Carolina DEHNR to support site closure.

The following sampling and testing activities were performed by Parsons ES during December 1998 at the site as part of this investigation:

- Conducted an aquifer slug test at 1 existing monitoring well, MW-3;
- Drilled 5 soil borings (SB1-SB5);
- Collected 12 subsurface soil samples for field headspace screening and fixed-base laboratory analysis from 5 borings;
- Collected groundwater samples for field and fixed-base laboratory analysis from 6 existing groundwater monitoring wells and 2 newly-installed monitoring points (MPs); and
- Collected 1 soil gas sample for laboratory analysis.

Analytical method detection limit (MDL) requirements were considered before site characterization work was initiated. Suitable analytical methods and quality control (QC) procedures were selected (Parsons ES, 1997a) to ensure that the data collected under this program are of sufficient quality to be used in a quantitative risk assessment.

Soil and groundwater samples were analyzed in the field and at laboratories operated by Quanterra, Inc. of Arvada, Colorado and Austin, Texas. Soil gas samples were analyzed in the field and by Air Toxics, Ltd. of Folsom, California. The laboratory data sheets and chain-of-custody records are presented in Appendix A. The analytical protocols for all samples are summarized in Table 2.1. Tables 2.2 and 2.3 summarize the field and fixed-base laboratory analyses performed by sampling location. These analyses and measurements were performed for various inorganic, geochemical, and physical parameters to document natural biodegradation processes and to assess the potential effectiveness of low-cost source reduction technologies.

2.2 SUBSURFACE SOIL SAMPLING

Soil samples were collected from the site to obtain soil total organic carbon (TOC) data, to facilitate evaluation of the potential for contaminant partitioning from soil into groundwater and soil gas, and to assess the magnitude of any changes in contaminant concentrations that have occurred over time. The soil boring locations are shown on Figure 2.1. These borings were advanced using a Geoprobe® hydraulic sampling rig as described in the SAP (Parsons ES, 1997).

Samples from 5 borings were described for lithology and field screened for volatile organic vapors using a photoionization detector (PID). Twelve soil samples from 5 borings were submitted to Quanterra, Inc. for laboratory analysis. Boring logs are included in Appendix C. Laboratory analyses for each soil sampling location are summarized in Table 2.2. Soil analytical results are summarized and discussed in Sections 4 and 5.

2.3 GROUNDWATER SAMPLING

Groundwater samples were collected from 6 existing MWs and 2 newly-installed MPs at the site in December 1998 (Figure 2.1). The groundwater samples were analyzed for fuel-related contaminants and for various inorganic and geochemical indicators to evaluate natural chemical and physical attenuation processes that are occurring at the site.

TABLE 2.1
ANALYTICAL PROTOCOL FOR
GROUNDWATER, SOIL, SURFACE WATER, AND SOIL GAS SAMPLES
Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina

MATRIX	METHOD	WHERE ANALYZED
GROUNDWATER		
Ferrous Iron (Fe^{+2})	Colorimetric, Hach Method 8146	Field
Sulfate (SO_4^{-2})	Colorimetric, Hach Method 8051	Field
Conductivity	Direct reading meter	Field
Dissolved Oxygen	Direct reading meter	Field
pH	Direct reading meter	Field
Redox Potential	Direct reading meter	Field
Temperature	Direct reading meter	Field
Volatile organic compounds (VOCs)	602	Quanterra[a/]
Semivolatile Organic Compounds (SVOCs)	625	Quanterra
Polynuclear aromatic hydrocarbons (PAHs)	SW8310	Quanterra
VPH/EPH[b/]	MADEP[c/]VPH/EPH	Specialized Assays[d/]
Methane (CH_4)	RSK-175	Quanterra
Nitrate as Nitrogen (NO_3^{-1}-N)	E300.0/SW9056	Quanterra
SOIL		
VOCs	SW8260	Quanterra
SVOCs	SW8270	Quanterra
VPH/EPH	VPH/EPH	Specialized Assays
Total Organic Carbon	SW9060	Quanterra
SOIL GAS		
BTEX/TPH[e/]	TO-3	Air Toxics[f/]
SURFACE WATER		
Aromatic VOCs	602	Quanterra

Notes:

a/ Quanterra, Inc. of Arvada, Colorado and Austin, Texas (methane only).
b/ VPH = volatile petroleum hydrcarbons, EPH = extractable petroleum hydrocarbons.
c/ MADEP = Massachusetts Department of Environmental Protection.
d/ Specialized Assays, Inc. of Nashville, TN (VPH/EPH only).
e/ BTEX = benzene, toluene, ethylbenzene,
and total xylenes, TPH = total petroleum hydrocarbons.
f/ Air Toxics LTD. of Folsom, California

TABLE 2.2
SOIL AND SOIL GAS ANALYSES BY SAMPLE LOCATION
Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina

	Sample Location Sample Matrix Depth (ft. bgs) [a/]					
ANALYTE[b/]	SB1 Soil 2.5-4	SB2 Soil 3-4	SB3 Soil 4.5-5.5	SB4 Soil 5	SB5 Soil 3	SG1 Soil gas 4-6
VOCs	X	X	X			
SVOCs	X	X	X			
EPH/VPH		X	X			
TOC				X	X	
BTEX						X
TPH						X

Notes:

a/ ft. bgs = feet below ground surface.

b/ VOCs = volatile organic compounds; SVOCs = semivolatile organic compounds; VPH/EPH = volatile petroleum hydrocarbons/extractable petroleum hydrocarbons; TOC = total organic carbon; BTEX = benzene, toluene, ethylbenzene, and xylenes; TPH = total petroleum hydrocarbons.

TABLE 2.3
GROUNDWATER ANALYSES BY SAMPLE LOCATION
Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina

ANALYTE[a/]	Sample Location							
	MPA	MPB	MW2	MW4	MW5	MW6	MW7	MW8
VOCs	x	x	x	x	x	x	x	x
SVOCs		x		x	x			
VPH/EPH		x		x				
Methane		x	x	x	x			
Nitrate		x	x	x	x			
ORP	x	x	x	x	x	x	x	x
Conductivity	x	x	x	x	x	x	x	x
Dissolved Oxygen	x	x	x	x	x	x	x	x
Temperature	x	x	x	x	x	x	x	x
pH	x	x	x	x	x	x	x	x
Ferrous Iron	x	x	x	x	x	x	x	
Sulfate		x	x	x	x	x		
Ammonium	x	x	x	x	x	x	x	
Alkalinity	x	x	x	x	x	x	x	

Notes:

a/ VOCs = volatile organic compounds; SVOCs = semivolatile organic compounds; VPH/EPH = volatile petroleum hydrocarbons/extractable petroleum hydrocarbons; ORP = oxidation-reduction potential.

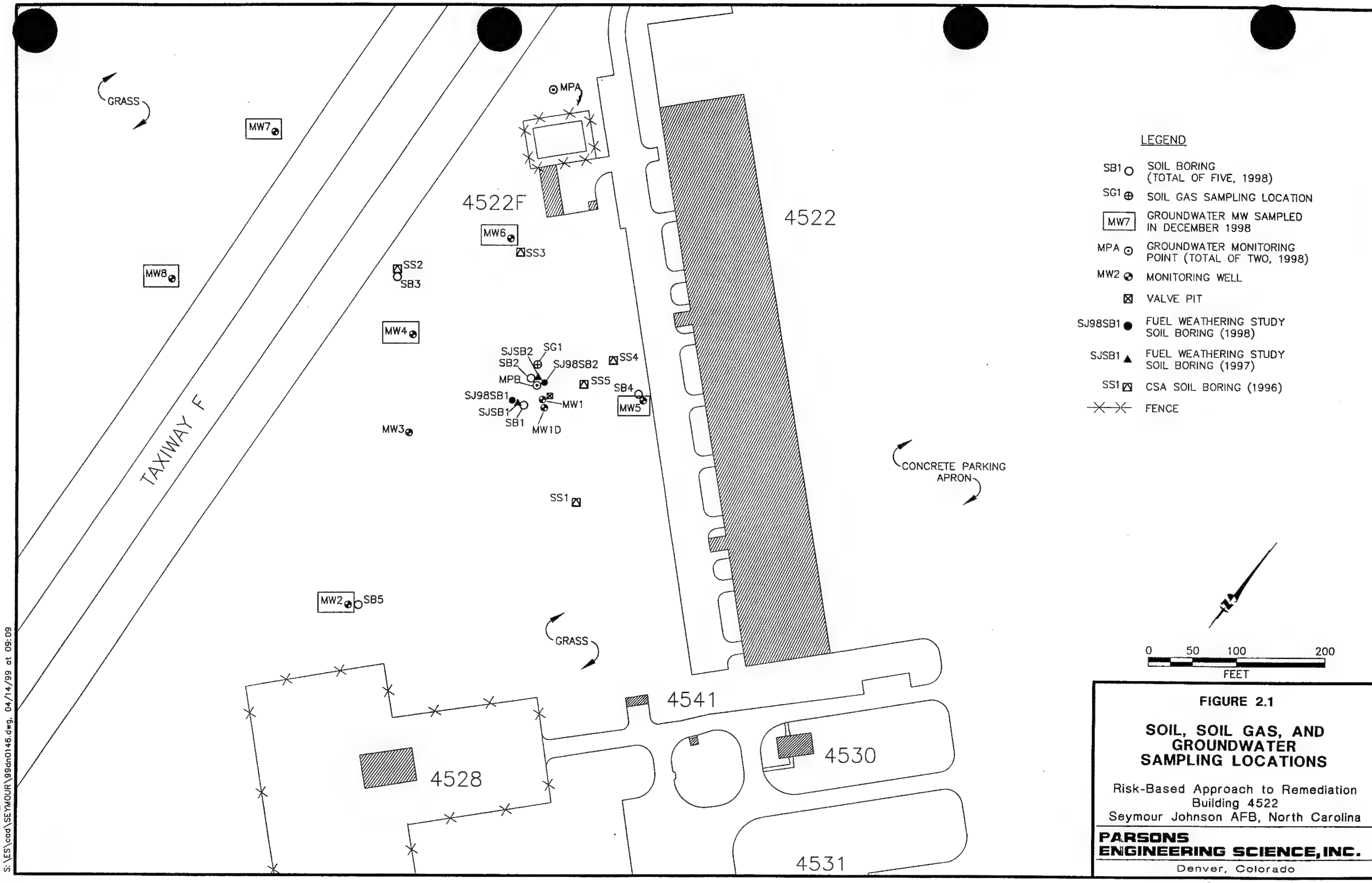

FIGURE 2.1

SOIL, SOIL GAS, AND GROUNDWATER SAMPLING LOCATIONS

Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina

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Denver, Colorado

Field and laboratory analyses for each groundwater sampling location are summarized in Table 2.3.

All MWs and permanently installed MPs were purged using a peristaltic pump with dedicated high-density polyethylene (HDPE) and silicone tubing. Purging consisted of removing groundwater from the well until the pH, dissolved oxygen (DO) concentration, oxidation/reduction potential (ORP), conductivity, and temperature stabilized.

Within 24 hours of the purge event, groundwater samples were collected from the monitoring wells using a peristaltic pump and dedicated tubing. The water was carefully poured down the inner walls of each sample bottle to minimize aeration of the sample. Sample bottles for VOCs, volatile petroleum hydrocarbons (VPH), methane, and/or Hach® field analyses were filled so that there was no headspace or air bubbles within the container.

Field and laboratory groundwater analytical results are discussed in Sections 4 through 6 of this report. These results are used in Section 6 to evaluate the natural physical, chemical, and biological processes that are affecting the COPCs at this site.

2.4 SURFACE WATER SAMPLING

Surface water samples were collected at two locations and analyzed for aromatic VOCs using USEPA Method 602. The surface water samples were collected from the storm water drainage system at entry point 164 and at the outfall of the drainage into the open ditch as shown on Figure 1.2. The samples were collected by lowering a clean 40-milliliter (ml) glass vial taped to a polyvinyl chloride (PVC) rod into the flow, filling the vial, and gently transferring the collected water into a second 40-ml vial.

2.5 SOIL GAS MEASUREMENTS

A soil gas sample was collected at the site for fixed-base laboratory analysis. The purpose of soil gas sampling was to assess the potential risk to future workers at the site from inhalation of volatilized contaminants.

Soil gas sample SG-1 was collected at the location shown on Figure 2.1 at a depth of 4-6 feet bgs. The sample was collected in a SUMMA® canister and submitted to Air Toxics, Ltd. in Folsom, California for analysis of total petroleum hydrocarbons (TPH) and BTEX using USEPA Method TO-3. Analytical results are summarized in Sections 4 and 5.

2.6 SLUG TESTS AND ANALYSIS

An aquifer slug test was conducted in one existing monitoring well at the site (MW3) in December 1998. The data were analyzed using the method described by Bouwer and Rice (1976) and Bouwer (1989). Analysis results are presented in Appendix D and discussed in Section 3.3.

2.7 EQUIPMENT DECONTAMINATION PROCEDURES

All downhole soil sampling tools (e.g., Geoprobe® drive-shoe and sampling barrel) were cleaned prior to collection of each sample with a clean water/phosphate-free detergent mix followed by a clean water rinse. Decontaminated tools also were used for soil gas sampling. The water level indicator probe was decontaminated prior to each use with a clean water/phosphate-free detergent mix followed by a distilled water rinse.

2.8 INVESTIGATION-DERIVED WASTES

Soil cuttings, unused soil samples, and purged groundwater were containerized in 55-gallon drums and moved to an approved on-Base storage area for later disposal by the Base.

2.9 SURVEYING

The horizontal location and top-of-casing elevation of each of the newly installed groundwater monitoring points were surveyed by the Parsons ES field crew using previously-surveyed MWs as benchmarks. Soil borings were located relative to major site features (e.g., road intersections, building corners) using a tape measure.

2.10 ANALYTICAL DATA QUALITY ASSESSMENT

2.10.1 Introduction

An electronic Level III validation was performed by a qualified chemist on the December 1998 analytical results obtained from Quanterra to determine data quality. The validation included internal data checks and application of data qualifiers to the analytical results based on adherence to method protocols and project-specific control limits. The electronic validation aided in assessing the quality of the data; however, professional judgement was used in applying qualifiers. A data quality assessment report is provided in Appendix G.

SECTION 3

PHYSICAL CHARACTERISTICS OF THE STUDY AREA

This section describes the physical characteristics of Building 4522 and adjacent environs at Seymour Johnson AFB, as determined from data collected during the CSA (Parsons ES, 1996) and by Parsons ES in December 1998 as part of the risk-based investigation. A summary of site characterization activities completed by Parsons ES to supplement existing data is presented in Section 2 of this CAP.

3.1 REGIONAL GEOLOGY AND HYDROGEOLOGY

The regional hydrogeologic units of the area correspond with the regional geologic units. Aquifers in the area range from surficial unconfined to confined aquifers. In localized areas, shallow groundwater is present in surficial aquifers consisting of Quaternary age sediments. Regionally, the surficial aquifer overlies the Black Creek aquifer, however, the Black Creek aquifer may locally occur as an unconfined surficial aquifer in areas of lower elevation surrounding the Neuse River. Regionally, the Black Creek aquifer is bounded above and below by the Black Creek and Cape Fear confining units, respectively. The Black Creek aquifer in the area ranges from approximately 30 feet thick west of the Neuse River and rapidly increases in thickness to the east (Winner and Lyke, 1989). The thickness of the underlying upper Cape Fear confining unit ranges from approximately 20 to 30 feet. The upper Cape Fear aquifer, which underlies the confining unit, is approximately 100 feet or more thick and is bounded at the bottom by undifferentiated clay and basement rocks (Winner and Lyke, 1989).

3.2 SITE GEOLOGY AND HYDROGEOLOGY

The shallow site geology includes a mix of unconsolidated deposits. Brown to light gray, fine- to medium-grained sand and silty sand generally occurs from ground surface to approximately 8 to 12 feet bgs. Interfingered layers of dark gray clay and fine- to medium-grained sand and silty sand underlie the surficial sands to a depth of approximately 40 feet bgs. A dark gray clay appears to be present below the clay/sand layer and extends to at least 47 feet bgs. Depth to groundwater during the CSA field activities ranged from 2.4 to 7.9 feet bgs across the site. Water level data indicated the presence of a slight mound in the water table in the vicinity of wells MW1 and MW3, with groundwater flow directions radiating outward from this area (Parsons ES, 1996) (Appendix B).

A hydraulic conductivity value for the shallow, surficial aquifer of 17 feet per day (ft/day) was derived from a 72-hour pumping test performed at the bulk terminal storage facility located approximately 700 feet east of the site (Law Environmental, 1992). During the December 1998 field effort, a slug test was conducted in well MW3. The slug

test results indicate that the hydraulic conductivity of the shallow water-bearing zone at the tested well was approximately 6.5 ft/day.

The groundwater depth in December 1998 ranged from approximately 4 to 10 feet bgs (Table 3.1). As shown in Figure 3.1, shallow groundwater is inferred to migrate in a predominantly westerly direction beneath the site. The hydraulic gradient along the contaminant migration pathway is estimated to be 0.003 foot per foot (ft/ft). Assuming an average hydraulic conductivity of 11.8 ft/day (average of 17 ft/day and 6.5 ft/day), and an effective porosity for a silty sand of 0.15 (Spitz and Moreno, 1996), the average advective groundwater velocity is estimated to be 0.24 ft/day [86 feet per year (ft/year)].

3.3 SITE TOPOGRAPHY AND SURFACE WATER HYDROLOGY

The area has relatively flat topography, with ground elevations at the site at approximately 100 feet above mean sea level (amsl). Surface water hydrology around the site is dominated by the stormwater sewer system. The closest surface water body to the site is Stoney Creek, which is located approximately 2,700 feet northwest of the site (Figure 1.2). Stoney Creek is the receiving body of water for a majority of the Base storm water drainage. A north-south-trending storm sewer traverses the site approximately 200 feet west of the spill location. As described in Section 1.5, the storm water line discharges to Stoney Creek approximately 2,700 feet west of the spill location.

3.4 WATER WELL SURVEY RESULTS

Based on information supplied by Seymour Johnson AFB, the Base receives water from the city of Goldsboro, and no water supply wells are located within 1,500 feet of the site.

TABLE 3.1
GROUNDWATER ELEVATIONS - DECEMBER 1, 1998
Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina

Location	TOC [a] Elevation (ft msl) [b]	Depth to Water (ft below TOC)	Groundwater Elevation (ft msl)
MPA	102.16	9.5	92.66
MW2	96.78	4.2	92.58
MW3	98.3	5.55	92.75
MW4	99.35	7.08	92.27
MW5	101.92	9.25	92.67
MW6	100.43	8.64	91.79
MW7	99.5	8.1	91.4
MW8	98.76	7.44	91.32

Notes:
[a] TOC = top of PVC casing
[b] ft msl = feet above mean sea level

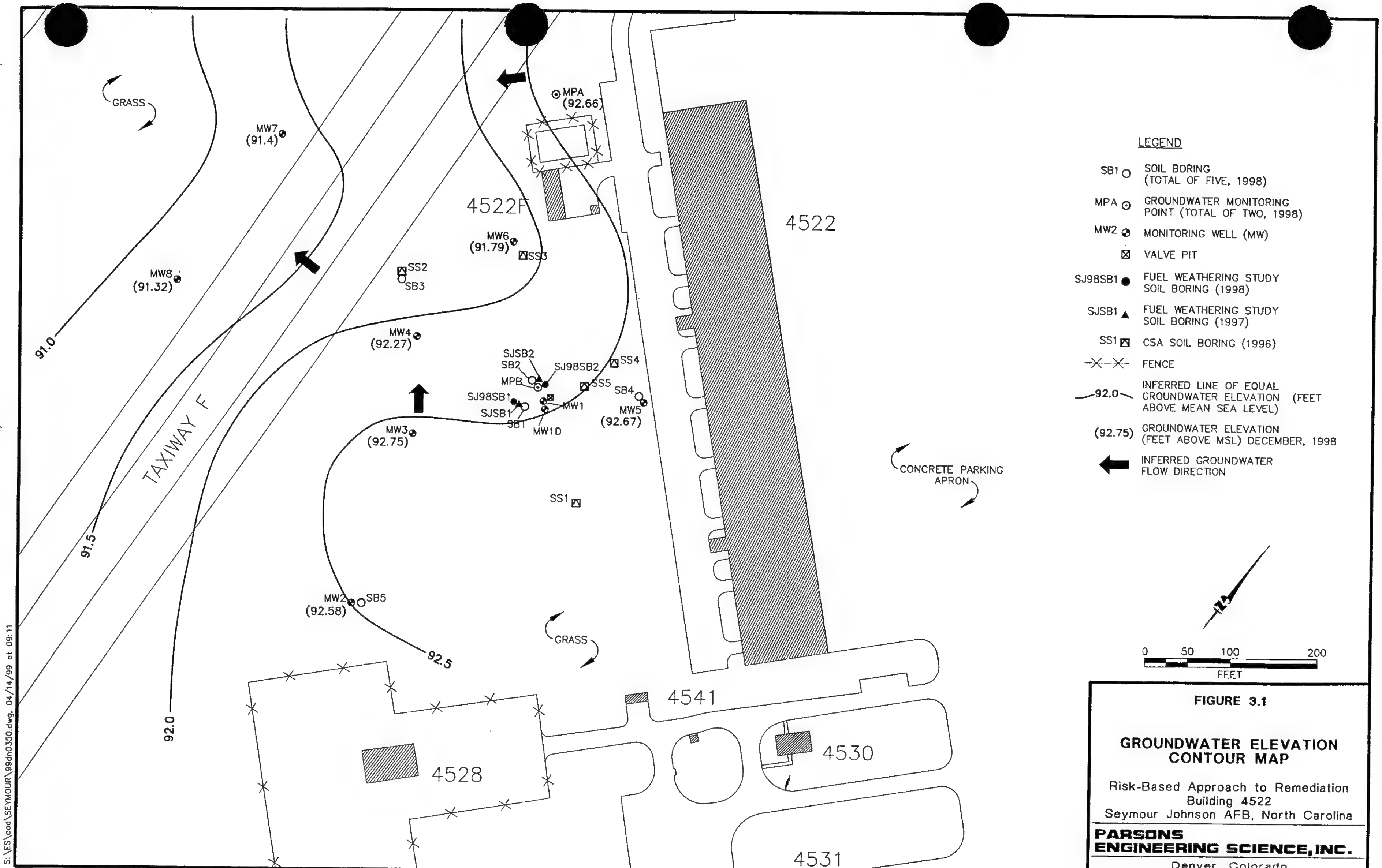

FIGURE 3.1

GROUNDWATER ELEVATION CONTOUR MAP

Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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SECTION 4

TIER 1 ANALYSIS AND IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN

This section provides an overview of the regulatory requirements for a risk-based, tiered approach to identification of COPCs and reviews the preliminary conceptual site model (CSM) developed for Building 4522 in the work plan (Parsons ES, 1998). The CSM was used to select appropriate regulatory screening criteria and to identify COPCs in affected site media (i.e., chemicals present at concentrations that could pose a risk to human and/or ecological receptors exposed to the affected media). This section also presents a Tier 1 analysis used to select the COPCs that are the focus of this CAP. The COPCs for the site are identified in the Tier 1 analysis based on estimated risks to human health posed by maximum detected contaminant concentrations.

4.1 REGULATORY REVIEW OF THE TIER 1 SCREENING PROCESS

As an initial step in determining the necessity for remedial action at Building 4522, representative concentrations of site contaminants are compared to appropriate soil and groundwater screening criteria presented in Tables 4 and 7 of the *Groundwater Section Guidelines for the Investigation and Remediation of Soil and Groundwater,* Volume II, Petroleum Underground Storage Tanks (USTs) (North Carolina DEHNR, 1998a). Contaminant soil concentrations must be below the Industrial/Commercial target levels presented in Table 4. Concentrations of COPCs in groundwater must be below the GCLs presented in Table 7.

Those analytes with site concentrations that exceed the appropriate criteria for soil and groundwater are considered to be COPCs, and are retained for further analysis concerning the risk-reduction requirements for the site. The nature and extent of these COPCs are described more fully in Section 5. Qualitative and quantitative fate and transport analyses are presented in Section 6 to evaluate the migration and persistence of COPCs in affected media.

4.2 PRELIMINARY CONCEPTUAL SITE MODEL REVIEW

Figure 4.1 presents the preliminary CSM developed for the site. The model was developed using data collected during previous site investigations and is based on a review of potential receptors and feasible exposure scenarios. The purpose of developing a CSM is to guide the evaluation of available site information, including:

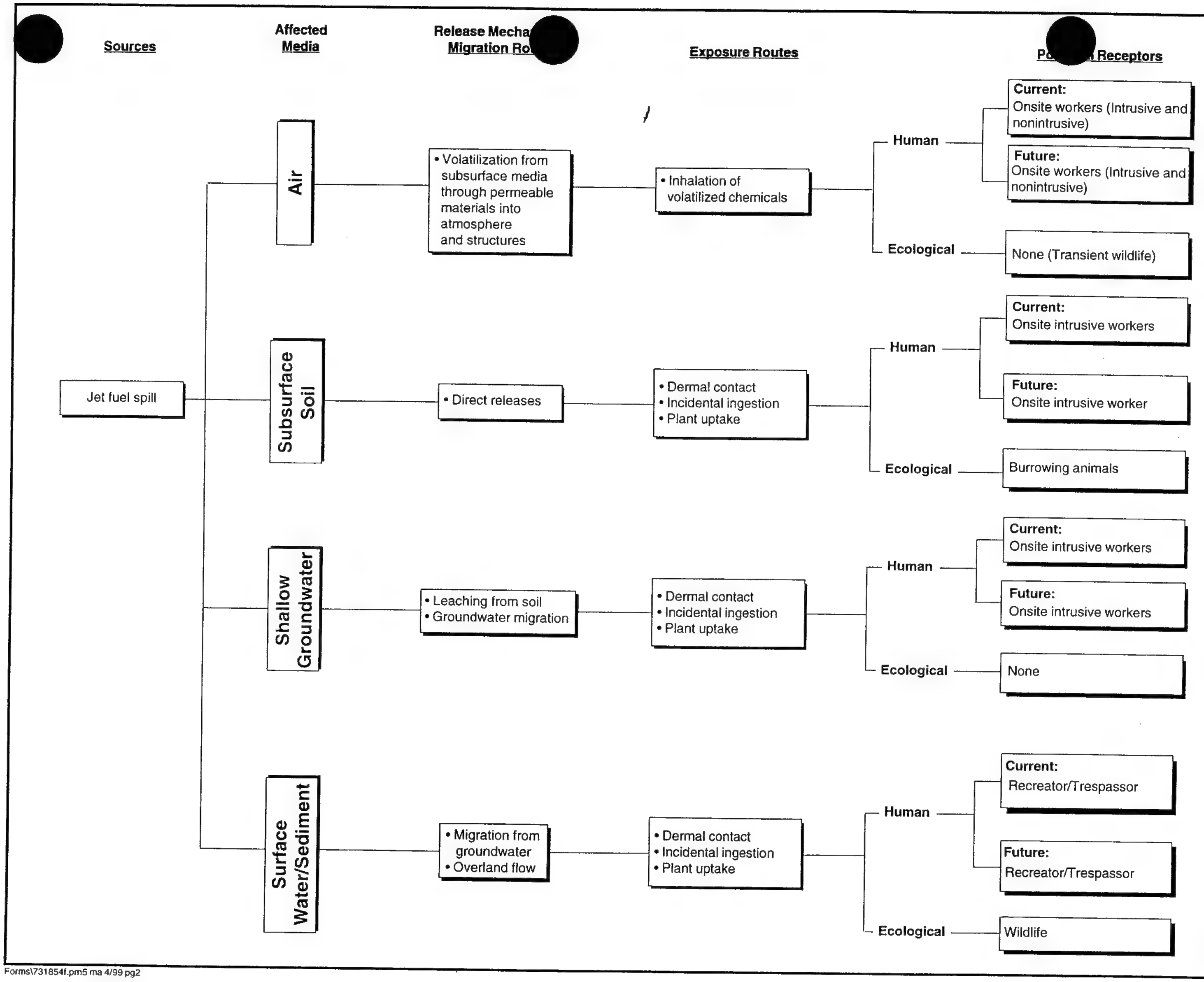

FIGURE 4.1

PRELIMINARY CONCEPTUAL SITE MODEL

Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

Forms\731854f.pm5 ma 4/99 pg2

- Potential contaminant sources;
- Mechanisms of contaminant release (e.g., leaching and volatilization) and potential migration routes;
- Media affected by contaminant releases;
- Routes of possible receptor exposure (e.g., inhalation, ingestion, or dermal contact); and
- Potential human and ecological receptors based on conservative, reasonable land use assumptions.

The CSM also was developed to provide an outline for addressing all media-specific current and future exposure scenarios at the site. The CSM has been constructed to identify potentially completed receptor exposure pathways. For an exposure pathway to be completed, there must be a contaminant source, a release mechanism, a contaminant migration pathway, an exposure route, and a receptor. If any of these components is missing, the pathway is considered incomplete, and receptors are not at risk from exposure to site contaminants.

4.2.1 Potential Contaminant Sources, Potential Release Mechanisms, and Potentially Affected Media

As shown on Figure 1.3, the source of the fuel contamination at Building 4522 is the underground jet fuel valve pit and distribution system. The initial mechanism of release was attributed to an ineffective "O"-ring seated in a flexible coupling, resulting in direct release of jet fuel to surface soil. Continuing release mechanisms may include adsorption of fuel hydrocarbons to soil from contaminated groundwater, volatilization of hydrocarbons from soil and groundwater into the atmosphere, partitioning of hydrocarbons from contaminated soil into groundwater, and discharge of contaminated groundwater to the storm sewer. Air, soil, shallow groundwater, and surface water in Stoney Creek and in the open ditch upstream from Stoney Creek (Figure 1.2), are the potentially affected physical media at or downgradient from the site.

4.2.2 Potential Exposure Routes

An understanding of potential exposure pathways is important in determining how potential receptors could contact contaminated media and how that contact could result in the uptake of chemicals. Potential exposure routes by which contaminants could impact potential receptors include the following:

- Uptake of contamination from soil, groundwater, or surface water by local vegetation;
- Dermal contact with or incidental ingestion of contaminated soil by site workers (e.g., during excavation activities);
- Inhalation of volatilized contaminants by site workers or transient wildlife;

- Dermal contact with or incidental ingestion of contaminated groundwater by site workers (e.g., during excavation activities); and
- Dermal contact with or incidental ingestion of contaminated surface water by recreators along the open storm water drainage ditch.

4.2.3 Land Use and Potential Receptors

On the basis of available site-specific information, current and future land use at the site is assumed to be industrial/commercial as opposed to residential. The site is an undeveloped area adjacent to an active aircraft maintenance and repair facility (Building 4522) located adjacent to Taxiway F. Access to the site is restricted due to the proximity of the taxiways, runways, and flightline apron. Potential receptors include onsite intrusive and non-intrusive workers, site vegetation, and transient wildlife. The storm water drainage ditch, a surface water body located approximately 1,000 feet downgradient from the site, is not classified as a fishery, but public access to the drainage ditch is not restricted. Therefore, trespassers or recreators in the drainage ditch also are potential receptors.

4.3 TIER 1 SCREENING ANALYSIS

It is the intention of the Air Force to obtain North Carolina DEHNR approval for a corrective action for the site that will protect potential receptors from unacceptable exposures to site-related chemicals. To accomplish this objective, the COPCs that drive potential risks and impact the final remedial requirements at this site were identified.

North Carolina DEHNR (1998a) Tier 1 screening criteria are based on 1) analyte-specific toxicity data; 2) an exposure-pathway-specific cancer target risk limit of 10^{-6} (i.e., one additional cancer above the background rate in a population of one million) and a noncancer hazard quotient limit of 0.2; and 3) conservative receptor exposure assumptions.

4.3.1 Tier 1 Screening Analysis for Soil

Industrial/commercial screening criteria were selected as the appropriate set of Tier 1 screening values for soil at the site. The North Carolina DEHNR (1998a) guidance provides industrial/commercial screening levels for petroleum constituents in soil that incorporate risks posed by the ingestion pathways. Table 4.1 compares the maximum concentrations for each compound measured in soil at the site during the March 1998 fuel weathering study (Parsons ES, 1999) (Appendix B) and the December 1998 risk-based sampling event to the industrial/commercial screening criteria. Based on these comparisons, there are no constituents identified as COPCs in soil.

The maximum soil contaminant concentrations were not compared to the residential screening criteria presented in Table 4 of North Carolina DEHNR (1998a). The residential screening criteria were established to protect the health of children and adult residents that may be exposed to contaminated soil. Soil concentrations also were not compared to soil-to-groundwater screening criteria due to the current and expected future industrial land use at this site. The soil-to-groundwater criteria were established to ensure

TABLE 4.1
TIER 1 SCREENING SUMMARY FOR SOIL
Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina

Analyte	Units	Maximum Concentration	Location (and Depth Interval in ft bgs) of Concentration	Industrial/ Commercial[a]
Benzene	mg/kg[b]	2.3 UJ[c]	SB2-4	200
Ethylbenzene	mg/kg	6.4 J	SB2-4	40,000
Toluene	mg/kg	2.7	SB1-2.5	82,000
Xylenes (total)	mg/kg	31.1	SB2-4	200,000
Aliphatics				
C5-C8	mg/kg	27.7	SB3-6	24,528
C9-C18	mg/kg	3,188	SB2-5	245,280
C19-C36	mg/kg	14.5	SB2-5	NA[d]
Aromatics				
C9-C22	mg/kg	1,071	SB2-5	12,264

Acenaphthene	mg/kg	7.5 U	SB1-4	24,000
Acenaphthylene	mg/kg	7.5 U	SB1-4	12,264
Anthracene	mg/kg	7.5 U	SB1-4	122,000
Benzo(a)anthracene	mg/kg	7.5 U	SB1-4	8
Benzo(a)pyrene	mg/kg	7.5 U (0.51)[e]	SB1-4	0.78
Benzo(b)fluoranthene	mg/kg	7.5 U	SB1-4	8
Benzo(g,h,i)perylene	mg/kg	7.5 U	SB1-4	12,264
Benzo(k)fluoranthene	mg/kg	--[f]	--	78
n-Butylbenzene	mg/kg	13 J	SB2-4	4,088
sec-Butylbenzene	mg/kg	6.8 J	SB2-4	4,088
tert-Butylbenzene	mg/kg	8 UJ	SB2-4	4,088
n-Propylbenzene	mg/kg	6.2 J	SB2-4	4,088
Chlorobenzene	mg/kg	2.3 UJ	SB2-4	NA
Chrysene	mg/kg	7.5 U	SB1-4	780
Dibenz(a,h)anthracene	mg/kg	7.5 U (0.79)[e]	SB1-4	0.78
1,2-Dibromoethane	mg/kg	3.4 U (0.012)[e]	SB2-4	0.067
1,2-Dichlorobenzene	mg/kg	7.5 U	SB1-4	36,000
1,3-Dichlorobenzene	mg/kg	7.5 U	SB1-4	36,000
1,4-Dichlorobenzene	mg/kg	7.5 U	SB1-4	240
1,1-Dichloroethane	mg/kg	2.3 UJ	SB2-4	40,000
1,2-Dichloroethane	mg/kg	3.4 UJ	SB2-4	63
1,1-Dichloroethene	mg/kg	6.9 UJ (0.3)[e]	SB2-4	10
1,2-Dichloroethene (cis)	mg/kg	<6.9 U	SB2-4	4,000
1,2-Dichloroethene (trans)	mg/kg	3.4 U	SB2-4	8,200
1,2-Dichloropropane	mg/kg	2.3 UJ	SB2-4	84
1,3-Dichloropropene (cia and trans)	mg/kg	2.3 U	SB2-4	33
Fluoranthene	mg/kg	2.3 U	SB1-4	16,400
Fluorene	mg/kg	7.5 U	SB1-4	16,400
Indeno(1,2,3-cd)pyrene	mg/kg	7.5 U	SB1-4	8.0
Isopropyl benzene	mg/kg	3.5 J	SB2-4	40,880
Isopropyl ether	mg/kg	--	--	4,088
2-Methylnaphthalene	mg/kg	31	SB1-4	1,635
MTBE	mg/kg	--	--	4,088
Naphthalene	mg/kg	31	SB1-4	1,635
Phenanthrene	mg/kg	7.5 U	SB1-4	12,264
Pyrene	mg/kg	7.5 U	SB1-4	12,264
1,2,4-Trimethylbenzene	mg/kg	52 J	SB2-4	20,440
1,3,5-Trimethylbenzene	mg/kg	25 J	SB2-4	20,440

Notes:

a/ Target cleanup levels from North Carolina DEHNR (1998a).

b/ mg/kg = Milligrams per kilogram.

c/ U = The analyte was analyzed for and is not present above the associated reporting limit; J= The analyte was positively identified, but the value may not be representative of what is actually present.

d/ NA = Not available.

e/ In cases where the maximum sample reporting limit exceeds the target cleanup level, the sample-specific method detection limit (MDL) is given in parentheses. The analyte concentration is less than the MDL.

f/ -- = analyte not targeted for analysis.

that leaching of residual contamination adsorbed to soil particles will not result in groundwater contaminant concentrations that exceed drinking water standards; therefore, these criteria are not appropriate for this site. At the Building 4522 site, two rounds of groundwater quality data indicate that the soil contamination is not sufficient to cause groundwater contaminant concentrations to exceed GCLs (Section 4.3.2). Based on these comparisons, there are no constituents identified as COPCs in soil.

4.3.2 Tier 1 Screening Analysis for Groundwater

The Tier 1 GCLs for groundwater presented by the North Carolina DEHNR (1998a) are compared to maximum dissolved contaminant concentrations detected in December 1998 in Table 4.2. Based on these comparisons, there are no specific fuel hydrocarbons identified as COPCs in groundwater. However, the C5-C8 and C9-C18 aliphatics and the C9-C22 aromatics exceed their respective interim groundwater standards published in 15A NCAC 26. There are no GCLs for these classes of compounds.

4.3.3 Tier 1 Screening Analysis for Surface Water

All surface waters in North Carolina are assigned a primary classification by the North Carolina Division of Water Quality. All waters must at least meet the standards for Class C (fishable/swimmable) waters. The other primary classifications provide additional levels of protection for primary contact recreation (Class B) and drinking water (Water Supply Classes I through V). The analytical results for the surface water samples obtained from the storm water drain (Section 2.4) were compared to Class C surface water standards to assess the presence of COPCs. The only petroleum hydrocarbon compound represented in the Class C standards is toluene, which has a standard of 11 micrograms per liter (μg/L). Toluene was not detected in either sample at a reporting limit of 0.5 μg/L. Detectable concentrations of other targeted aromatic VOCs also were not present. Therefore, there are no COPCs in surface water.

4.3.4 Tier 1 Screening Analysis for Soil Gas

North Carolina DEHNR (1998a) guidance currently does not provide screening criteria for soil gas concentrations or for directly screening ambient air values. As a means of assessing the potential for exposure via inhalation of volatiles, the soil gas samples collected in December 1998 were analyzed for BTEX and TPH, and maximum detections of each of the BTEX compounds were compared to the chemical-specific Occupational Safety and Health Administration (OSHA) 8-hour time-weighted average Permissible Exposure Limit (PEL) (NIOSH, 1997) and time-weighted-average Threshold Limit Values (TWA-TLVs) determined by the American Conference of Government Industrial Hygienists (ACGIH, 1996). Table 4.3 presents the results of this comparison. Benzene, toluene, and xylenes were detected above the OSHA PELs or the TWA-TLVs, indicating that inhalation of volatilized contaminants could pose a risk to excavation workers.

TABLE 4.2
TIER 1 SCREENING SUMMARY FOR GROUNDWATER
Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina

Analyte	Units	Maximum Detection	Detection Location	GCL[a/]
Benzene	μg/L [b/]	1,300	MW4	5,000
Ethylbenzene	μg/L	650	MW4	29,000
Toluene	μg/L	2,900	MPB	257,500
Xylenes (total)	μg/L	2,300	MW4	87,500
Aliphatics				
C5-C8	μg/L	12.2	MPB	0.42[c/]
C9-C18	μg/L	5.2	MPB	4.2[c/]
C19-C36	μg/L	0.1 U	MPB	42[c/]
Aromatics				
C9-C22	μg/L	2.5	MPB	0.21[c/]
Acenaphthene	μg/L	10U [d/]	NA	2,120
Acenaphthylene	μg/L	10U	NA	1,965
Anthracene	μg/L	10U	NA	645
Benzo(a)anthracene	μg/L	10U	NA	22.0
Benzo(a)pyrene	μg/L	0.23U	NA	1.5
Benzo(b)fluoranthene	μg/L	0.18U	NA	0.6
Benzo(g,h,i)perylene	μg/L	10U	NA	210
Benzo(k)fluoranthene	μg/L	0.17U	NA	0.5
Chlorobenzene	μg/L	50U	NA	50,000
Chrysene	μg/L	0.20U	NA	5
Dibenz(a,h)anthracene	μg/L	0.3U	NA	0.3
1,2-Dichlorobenzene	μg/L	50U	NA	72,500
1,3-Dichlorobenzene	μg/L	50U	NA	61,500
1,4-Dichlorobenzene	μg/L	50U	NA	39,500
2,4-Dimethyl phenol	μg/L	12	MW4	NA[e/]
Fluoranthene	μg/L	10U	NA	280
Fluorene	μg/L	10U	NA	950
Indeno(1,2,3-cd)pyrene	μg/L	10U	NA	31.0
MTBE	μg/L	1.5 J[f/]	MPA	200,000
Naphthalene	μg/L	210	MW4	15,500
Phenanthrene	μg/L	10U	NA	410
Pyrene	μg/L	10U	NA	210
1,2,4-Trimethylbenzene	μg/L	10U	NA	28,500

Notes: Shaded area denotes that detected concentration exceeds the GCL for that contaminant.

a/ GCL = gross contaminant level [North Carolina DEHNR (1998a)]

b/ μg/L = micrograms per liter.

c/ Interim Groundwater Standard (15A NCAC 26).

d/ U = the analyte was analyzed for and is not present above the associated reporting limit.

e/ NA = not available.

f/ J = This is an estimated result. The analyte was positively identified and has a concentration between the method detection limit and the reporting limit.

TABLE 4.3
TIER 1 SCREENING SUMMARY FOR SOIL GAS
Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina

Analyte	Maximum Detection (ppmv [a])	OSHA PEL [b] (ppmv)	TLV [c] (ppmv)
Benzene	260	1	0.5
Ethylbenzene	32	100	100
Toluene	59	100	50
Xylenes (total)	110 M[d]	100	100
TPH (C5+)[e]	110,000 B[f]	--[g]	--

Notes:

Shading indicates that the maximum analyte concentration exceeds the PEL and/or the TLV.

a/ ppmv = parts per million, volume per volume.

b/ OSHA PEL = Occupational Safety and Health Administration (NIOSH, 1997) 8-hour time-weighted-average permissible exposure limit.

c/ TLV = Time weighted average threshold limit value -- Recommended by the American Conference of Government Industrial Hygienists (ACGIH), 1996.

d/ M = Reported value may be biased due to apparent matrix interferences as reported by the laboratory.

e/ TPH = Total Petroleum Hydrocarbons, referenced to JP-5 jet fuel.

f/ B = Compound was found present in the laboratory blank, background subtraction was not performed.

g/ -- = no comparison value available.

4.3.5 Summary of Site COPCs

Based on comparisons of the maximum soil, groundwater, and soil gas concentrations to North Carolina DEHNR (1998a) screening criteria, OSHA PELs (NIOSH, 1997), and TLVs (ACGIH, 1996), volatilized benzene, toluene, and xylenes are the only constituents identified as COPCs for Building 4522.

SECTION 5

ANALYTICAL DATA SUMMARY AND EXTENT OF CHEMICALS OF POTENTIAL CONCERN

5.1 OVERVIEW

This section presents analytical results from the December 1998 field sampling event in tabular form, and summarizes the magnitude and extent of selected constituents in sampled media at Building 4522.

5.2 SOIL SAMPLING RESULTS

Soil sampling was performed as part of the recent risk-based investigation. Field screening results are summarized in Table 5.1, and laboratory analytical results are summarized in Table 5.2. Boring logs are included in Appendix C. Soil borings were advanced in areas of elevated fuel contamination (based on previous investigations) to determine worst-case hydrocarbon concentrations in soil, in addition to facilitating evaluation of the change in concentrations over time. Soil boring locations are shown on Figure 2.1. The soil sample locations were selected based on the known location of the contamination release point and analytical results for previously-collected soil samples.

A total of five soil samples were collected. Two of the sampling locations are located in the release area of the valve pit (SB1 and SB2), one sample was collected downgradient from the release point next to taxiway F (SB3), and two samples were collected outside of the contaminated area (SB4 and SB5) for the purpose of obtaining native TOC concentrations. Soil borings SB1, SB2, and SB3 were located adjacent to previous soil borings SJ98SB1, SJ98SB2, and SS2, respectively. These previous soil borings were drilled and sampled by Parsons ES in March 1998 and April 1996 during the CSA. The intent of sampling the same location and depth interval again was to facilitate the assessment of temporal changes in contaminant concentrations in these historically contaminated areas.

As shown in Table 4.1, no contaminant concentrations exceeding the Tier 1 industrial/commercial screening levels were detected. The highest concentrations of ionizable volatile organics detected using the PID were present in the 3- to 6-ft bgs depth interval in most of the borings at the site. The highest total BTEX concentrations were mostly detected in soil sample SB2, collected at 4 feet bgs, 2.5 feet above the estimated water table.

TABLE 5.1
SOIL BORING SUMMARY AND FIELD SCREENING RESULTS
Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina

Soil Boring	Boring Date	Highest PID Measurement (ppmv) [a] [Measurement Depth (ft bgs [b])]	Estimated Depth to Water (ft bgs)	Total Depth (ft bgs)
SB1	12/3/98	>200 (2.5 - 3)	5.0	7.0
SB2	12/2/98	170 (5 - 5.5)	6.5	7.5
SB3	12/3/99	>200 (6)	6.8	7.0
SB4	12/1/98	10 (5 - 6)	6.5	8.0
SB5	12/2/98	10 (2.5 - 3)	3.5	6.0

[a] ppmv = parts per million, volume per volume; PID = photoionization detector.
[b] ft bgs = feet below ground surface.

TABLE 5.2
SUMMARY OF SOIL ANALYTICAL DATA
Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina

Analyte	Units	Sample Location-Depth (ft bgs), Date, and Method									
		SB1-2.5 12/3/1998 8260	SB1-4 12/3/1998 8270	SB2-3 12/2/1998 8270	SB2-4 12/2/1998 8260	SB2-5 12/2/1998 VPH/EPH	SB3-4.5 12/3/1998 8270	SB3-5.5 12/3/1998 8260	SB3-6 12/3/1998 VPH/EPH	SB4-5 12/1/1998 9060	SB5-3 12/2/1998 9060
Benzene	mg/kg [a]	0.56 U [b]	--- [c]	---	2.3UJ [d]	---	---	0.11U	---	---	---
Ethylbenzene	mg/kg	**3.6**	---	---	**6.4J**	---	---	**0.97**	---	---	---
Toluene	mg/kg	**2.7**	---	---	**2.1J**	---	---	**0.13J1** [e]	---	---	---
Xylenes (total)	mg/kg	**20.1**	---	---	**31.1**	---	---	**4.8**	---	---	---
Aliphatics											
C5-C8	mg/kg	---	---	---	---	10	---	---	27.7	---	---
C9-C18	mg/kg	---	---	---	---	3,188	---	---	108	---	---
C19-C36	mg/kg	---	---	---	---	14.5	---	---	10.6	---	---
Aromatics											
C9-C22	mg/kg	---	---	---	---	1,071	---	---	72.1	---	---
Total Organic Carbon (TOC)	mg/kg	---	---	---	---	---	---	---	---	590J1	1980J1
Acenaphthene	mg/kg	---	7.5U	3.2U	---	---	0.77U	---	---	---	---
Acenaphthylene	mg/kg	---	7.5U	3.2U	---	---	0.77U	---	---	---	---
Anthracene	mg/kg	---	7.5U	3.2U	---	---	0.77U	---	---	---	---
Benzo(a)anthracene	mg/kg	---	7.5U	3.2U	---	---	0.77U	---	---	---	---
Benzo(b)fluoranthene	mg/kg	---	7.5U	3.2U	---	---	0.77U	---	---	---	---
Benzoic acid	mg/kg	---	17U	7.4U	---	---	1.8U	---	---	---	---
Benzo(g,h,i)perylene	mg/kg	---	7.5U	3.2U	---	---	0.77U	---	---	---	---
Benzo(a)pyrene	mg/kg	---	7.5U	3.2U	---	---	0.77U	---	---	---	---
bis (2-Chloroethoxy) methane	mg/kg	---	7.5U	3.2U	---	---	0.77U	---	---	---	---
bis (2-Chloroethyl) ether	mg/kg	---	7.5U	3.2U	---	---	0.77U	---	---	---	---
bis (2-Ethylhexyl) phthalate	mg/kg	---	7.5U	3.2U	---	---	0.77U	---	---	---	---
4-Bromophenyl phenyl ether	mg/kg	---	7.5U	3.2U	---	---	0.77U	---	---	---	---
Butyl benzyl phthalate	mg/kg	---	7.5U	3.2U	---	---	0.77U	---	---	---	---
Bromobenzene	mg/kg	0.56U	---	---	2.3UJ	---	---	11U	---	---	---
Bromochloromethane	mg/kg	0.56U	---	---	2.3UJ	---	---	0.11U	---	---	---
Bromodichloromethane	mg/kg	1.1U	---	---	4.6UJ	---	---	0.22U	---	---	---
Bromoform	mg/kg	1.7U	---	---	6.9UJ	---	---	0.33U	---	---	---
Bromomethane	mg/kg	1.4U	---	---	5.7UJ	---	---	0.28UJ	---	---	---
n-Butylbenzene	mg/kg	**5.8**	---	---	**13J**	---	---	**1.5**	---	---	---
sec-Butylbenzene	mg/kg	**2.6**	---	---	**6.8J**	---	---	**0.67**	---	---	---
tert-Butylbenzene	mg/kg	2U	---	---	8UJ	---	---	0.39U	---	---	---
4-Chloroaniline	mg/kg	---	14U	6U	---	---	1.4U	---	---	---	---
4-Chloro-3-methylphenol	mg/kg	---	14U	6U	---	---	1.4U	---	---	---	---
2-Chlorophenol	mg/kg	---	7.5U	3.2U	---	---	0.77U	---	---	---	---
4-Chlorophenyl phenyl ehter	mg/kg	---	7.5U	3.2U	---	---	0.77U	---	---	---	---
Carbon tetrachloride	mg/kg	2.8U	---	---	11UJ	---	---	0.56U	---	---	---
Chlorobenzene	mg/kg	0.56U	---	---	2.3UJ	---	---	0.11U	---	---	---
Chlorodibromomethane	mg/kg	0.84U	---	---	3.4UJ	---	---	0.17U	---	---	---
Chloroethane	mg/kg	1.4U	---	---	5.7UJ	---	---	0.28UJ	---	---	---
Chloroform	mg/kg	0.56U	---	---	2.3UJ	---	---	0.11U	---	---	---
1-Chlorohexane	mg/kg	0.84U	---	---	3.4UJ	---	---	0.17U	---	---	---
Chloromethane	mg/kg	2U	---	---	8UJ	---	---	0.39U	---	---	---
2-Chlorotoluene	mg/kg	0.56U	---	---	2.3UJ	---	---	0.11U	---	---	---
4-Chlorotoluene	mg/kg	0.84U	---	---	3.4UJ	---	---	0.17U	---	---	---
Chrysene	mg/kg	---	7.5U	3.2U	---	---	0.77U	---	---	---	---
Dibenzofuran	mg/kg	---	7.5U	3.2U	---	---	0.77U	---	---	---	---
3,3'-Dichlorobenzidine	mg/kg	---	14U	6U	---	---	1.4U	---	---	---	---
2,4-Dichlorophenol	mg/kg	---	3.2U	1.4U	---	---	0.33U	---	---	---	---
Diethyl phthalate	mg/kg	---	7.5U	3.2U	---	---	0.77U	---	---	---	---
2,4-Dimethylphenol	mg/kg	---	3.2U	1.4U	---	---	0.33U	---	---	---	---
Dimethyl phthalate	mg/kg	---	7.5U	3.2U	---	---	0.77U	---	---	---	---
4,6-Dinitro-2-methylphenol	mg/kg	---	35U	15U	---	---	3.6U	---	---	---	---
2,4-Dinitrophenol	mg/kg	---	35U	15U	---	---	3.6U	---	---	---	---
2,4-Dinitrotoluene	mg/kg	---	7.5U	3.2U	---	---	0.77U	---	---	---	---
2,6-Dinitrotoluene	mg/kg	---	7.5U	3.2U	---	---	0.77U	---	---	---	---
Di-n-octyl phthalate	mg/kg	---	7.5U	3.2U	---	---	0.77U	---	---	---	---
Dibenz(a,h)anthracene	mg/kg	---	7.5U	3.2U	---	---	---	---	---	---	---
Dibromomethane	mg/kg	2.8U	---	---	11UJ	---	---	0.56U	---	---	---
1,2-Dichlorobenzene	mg/kg	0.56U	7.5U	3.2U	2.3UJ	---	0.77U	0.11U	---	---	---
1,3-Dichlorobenzene	mg/kg	1.7U	7.5U	3.2U	6.9UJ	---	0.77U	0.33U	---	---	---
1,4-Dichlorobenzene	mg/kg	0.56U	7.5U	3.2U	2.3UJ	---	0.77U	0.11U	---	---	---
Dichlorodifluoromethane	mg/kg	1.4UJ	---	---	5.7UJ	---	---	0.28UJ	---	---	---
1,1-Dichloroethane	mg/kg	0.56U	---	---	2.3UJ	---	---	0.11U	---	---	---
1,2-Dichloroethane	mg/kg	0.84U	---	---	3.4UJ	---	---	0.17U	---	---	---
1,1-Dichloroethene	mg/kg	1.7UJ	---	---	6.9UJ	---	---	0.33U	---	---	---

TABLE 5.2 (Continued)
SUMMARY OF SOIL ANALYTICAL DATA
Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina

Analyte	Units	Sample Location-Depth (ft bgs), Date, and Method									
		SB1-2.5 12/3/1998 8260	SB1-4 12/3/1998 8270	SB2-3 12/2/1998 8270	SB2-4 12/2/1998 8260	SB2-5 12/2/1998 VPH/EPH	SB3-4.5 12/3/1998 8270	SB3-5.5 12/3/1998 8260	SB3-6 12/3/1998 VPH/EPH	SB4-5 12/1/1998 9060	SB5-3 12/2/1998 9060
1,1-Dichloroethylene	mg/kg	---	---	---	---	---	---	---	---	---	---
1,2-Dichloroethene (cis)	mg/kg	1.7U	---	---	6.9U	---	---	0.33U	---	---	---
1,2-Dichloroethene (trans)	mg/kg	0.84U	---	---	3.4U	---	---	0.17U	---	---	---
1,2-Dichloropropane	mg/kg	0.56U	---	---	2.3UJ	---	---	0.11U	---	---	---
1,3-Dichloropropane	mg/kg	0.56U	---	---	2.3UJ	---	---	0.11U	---	---	---
2,2-Dichloropropane	mg/kg	5.6U	---	---	23UJ	---	---	1.1U	---	---	---
1,1-Dichloropropene	mg/kg	1.4U	---	---	5.7UJ	---	---	0.28U	---	---	---
1,3-Dichloropropene (cis)	mg/kg	1.4U	---	---	5.7U	---	---	0.28U	---	---	---
1,3-Dichloropropene (trans)	mg/kg	1.4U	---	---	5.7U	---	---	0.28U	---	---	---
Fluoranthene	mg/kg	---	7.5U	3.2U	---	---	0.77U	---	---	---	---
Fluorene	mg/kg	---	7.5U	3.2U	---	---	0.77U	---	---	---	---
Trichlorofluoromethane	mg/kg	1.1UJ	---	---	4.6UJ	---	---	0.22U	---	---	---
Hexachlorobenzene	mg/kg	---	7.5U	3.2U	---	---	0.77U	---	---	---	---
Hexachlorobutadiene	mg/kg	1.4U	7.5U	3.2U	5.7U	---	0.77U	0.28U	---	---	---
Hexachlorocyclopentadiene	mg/kg	---	7.5U	3.2U	---	---	0.77U	---	---	---	---
Hexachloroethane	mg/kg	---	7.5U	3.2U	---	---	0.77U	---	---	---	---
Indeno(1,2,3-cd)pyrene	mg/kg	---	7.5U	3.2U	---	---	0.77U	---	---	---	---
Isophorone	mg/kg	---	7.5U	3.2U	---	---	0.77U	---	---	---	---
Isopropyl benzene	mg/kg	**2.0J1**	---	---	**3.5J**	---	---	**0.51**	---	---	---
p-Isopropyltoluene	mg/kg	1.7U	---	---	6.9UJ	---	---	0.33U	---	---	---
Isopropyl ether	mg/kg	---	---	---	---	---	---	---	---	---	---
Methylene chloride	mg/kg	0.42U	---	---	5.7UJ	---	---	0.28U	---	---	---
2-Methylnaphthalene	mg/kg	---	**31**	**8.9**	---	---	0.77U	---	---	---	---
2-Methylphenol	mg/kg	---	3.2U	1.4U	---	---	0.33U	---	---	---	---
Naphthalene	mg/kg	**7.1**	**31**	**7.2**	**20J**	---	0.77U	**1.3**	---	---	---
2-Nitroaniline	mg/kg	---	35U	15U	---	---	3.6U	---	---	---	---
3-Nitroaniline	mg/kg	---	35U	15U	---	---	3.6U	---	---	---	---
4-Nitroaniline	mg/kg	---	35U	15U	---	---	3.6U	---	---	---	---
Nitrobenzene	mg/kg	---	7.5U	3.2U	---	---	0.77U	---	---	---	---
2-Nitrophenol	mg/kg	---	3.2U	1.4U	---	---	0.33U	---	---	---	---
4-Nitrophenol	mg/kg	---	17U	7.4U	---	---	1.8U	---	---	---	---
N-Nitrosodiphenylamine	mg/kg	---	7.5U	3.2U	---	---	0.77U	---	---	---	---
N-Nitrosodi-n-propylamine	mg/kg	---	7.5U	3.2U	---	---	0.77U	---	---	---	---
Pentachlorophenol	mg/kg	---	35U	15U	---	---	3.6U	---	---	---	---
n-Propylbenzene	mg/kg	**3.8**	---	---	**6.2J**	---	---	**1**	---	---	---
Phenanthrene	mg/kg	---	7.5U	3.2U	---	---	0.77U	---	---	---	---
Phenol	mg/kg	---	3.2U	1.4U	---	---	0.33U	---	---	---	---
Pyrene	mg/kg	---	7.5U	3.2U	---	---	0.77U	---	---	---	---
Styrene	mg/kg	0.56U	---	---	2.3UJ	---	---	0.11U	---	---	---
1,1,1,2-Tetrachloroethane	mg/kg	0.84U	---	---	3.4UJ	---	---	0.17U	---	---	---
1,1,2,2-Tetrachloroethane	mg/kg	0.56U	---	---	2.3UJ	---	---	0.11U	---	---	---
Tertrachloroethene	mg/kg	2U	---	---	8UJ	---	---	0.39U	---	---	---
1,2,3-Trichlorobenzene	mg/kg	0.56U	---	---	2.3UJ	---	---	0.11U	---	---	---
1,2,4-Trichlorobenzene	mg/kg	0.56U	7.5U	3.2U	2.3UJ	---	0.77U	0.11U	---	---	---
1,1,1-Trichloroethane	mg/kg	1.1U	---	---	4.6UJ	---	---	0.22U	---	---	---
1,1,2-Trichloroethane	mg/kg	1.4U	---	---	5.7UJ	---	---	0.28U	---	---	---
Trichloroethene	mg/kg	2.8U	---	---	11UJ	---	---	0.56U	---	---	---
1,2,3-Trichloropropane	mg/kg	5.6U	---	---	23UJ	---	---	1.1U	---	---	---
2,4,5-Trichlorophenol	mg/kg	---	35U	15U	---	---	3.6U	---	---	---	---
1,2,4-Trimethylbenzene	mg/kg	**21**	---	---	**52J**	---	---	**5**	---	---	---
1,3,5-Trimethylbenzene	mg/kg	**13**	---	---	**25J**	---	---	**2.3**	---	---	---
Vinyl chloride	mg/kg	2.5UJ	---	---	10UJ	---	---	0.5U	---	---	---
Benzyl alcohol	mg/kg	---	14U	6U	---	---	1.4U	---	---	---	---
bis (2-Chloroisopropyl) ether	mg/kg	---	7.5U	3.2U	---	---	0.77U	---	---	---	---
2-Chloronaphthalene	mg/kg	---	7.5U	3.2U	---	---	0.77U	---	---	---	---
1,2-Dibromo-3-chloropropane	mg/kg	2.8UJ	---	---	11UJ	---	---	0.56U	---	---	---
1,2-Dibromoethane	mg/kg	0.84U	---	---	3.4UJ	---	---	0.17U	---	---	---
Di-n-butyl phthalate	mg/kg	---	7.5U	3.2U	---	---	0.77U	---	---	---	---
4-Methylphenol	mg/kg	---	3.2U	1.4U	---	---	0.33U	---	---	---	---
2,4,6-Trichlorophenol	mg/kg	---	3.2U	1.4U	---	---	0.33U	---	---	---	---

Note: Shaded areas denote all detected concentrations.
a/ mg/kg = Milligrams per kilogram.
b/ U = The analyte was analyzed for and is not present above the reporting limit shown.
c/ --- = Not analyzed.
d/ J = The analyte was positively identified, but the value may not be representative of what is actually present.
e/ J1 = This is an estimated result. The analyte was positively identified and has a concentration between the method detection limit and the reporting limit.

5.3 GROUNDWATER SAMPLING RESULTS

Groundwater sampling was performed as part of the recent risk-based investigation; analytical results are summarized in Table 5.3, and the distribution of total dissolved BTEX and benzene concentrations are depicted on Figures 5.1 and 5.2, respectively. Sample locations were selected based on the results of previous investigations and the objectives of this study. The sampling objectives were to determine the current areal extent and magnitude of fuel hydrocarbon concentrations in groundwater, and to obtain the appropriate chemical and geochemical data to document the occurrence and significance of biodegradation processes. As shown in Table 4.2, maximum concentrations of dissolved aliphatics (EPH) and aromatics (VPH) exceeded their respective Tier 1 screening levels (interim groundwater standards). The locations of the exceedences were at onsite wells MPB and MW4 (Figure 5.1). The state of North Carolina has not established GCLs for dissolved EPH and VPH.

Figure 5.1 indicates that in December 1998, the dissolved BTEX plume extended beneath Taxiway F. Comparison of total BTEX concentrations measured at downgradient well MW7 in 1996 (3 μg/L) (Parsons ES, 1996) and December 1998 (37 μg/L) suggests that the plume expanded slightly during this time period.

5.4 SURFACE WATER SAMPLING RESULTS

Two surface water samples were collected from the storm drain that traverses the site (Figure 1.2). One sample was collected at entry point 164, located immediately west of (downgradient from) the spill location, and the second sample was collected further to the northwest (downstream) where the drain empties into the open ditch. Analytical results are summarized in Table 5.4. None of the aromatic VOCs targeted for analysis were detected.

5.5 SOIL GAS SAMPLING RESULTS

One soil gas sample was collected at the site to facilitate assessment of the potential risk to future workers at the site from inhalation of VOCs. The soil gas sample was collected at a depth of 4 to 6 feet bgs from the area containing relatively elevated soil contaminant concentrations (Figure 2.1). The samples were submitted to Air Toxics, Ltd. of Folsom California for analysis of BTEX and TPH (referenced to JP-5 jet fuel). Field and laboratory analytical results for the December 1998 soil gas samples are summarized in Table 5.5. Maximum soil gas BTEX concentrations are compared to OSHA 8-hour time-weighted average PELs and TLVs in Table 4.3.

TABLE 5.3
SUMMARY OF GROUNDWATER ANALYTICAL DATA
Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina

Analyte	Units	Sample Location, Date, and Method												
		MPA 12/3/1998 602	MPB 12/3/1998 602	MPB 12/3/1998 625	MPB 12/3/1998 8310	MPB 12/3/1998 RSK-175	MPB 12/3/1998 EPH/VPH	MPB 12/3/1998 9056	MW2 12/3/1998 602	MW2 12/3/1998 RSK-175	MW2 12/3/1998 9056	MW4 12/3/1998 602	MW4 12/3/1998 625	MW4 12/3/1998 8310
Benzene	µg/L[a]	**0.76**	**980**	---[b]	---	---	---	---	0.5U[c]	---	---	**1,300**	---	---
Ethylbenzene	µg/L	0.5U	**450**	---	---	---	---	---	0.5U	---	---	**650**	---	---
Toluene	µg/L	0.5U	**2,900**	---	---	---	---	---	0.5U	---	---	**2,200**	---	---
Xylenes (total)	µg/L	0.5U	**1,800**	---	---	---	---	---	0.5U	---	---	**2,300**	---	---
Aliphatics														
C5-C8	µg/L	---	---	---	---	---	**12,220**	---	---	---	---	---	---	---
C9-C18	µg/L	---	---	---	---	---	**5,250**	---	---	---	---	---	---	---
C19-C36	µg/L	---	---	---	---	---	100U	---	---	---	---	---	---	---
Aromatics														
C9-C22	µg/L	---	---	---	---	---	**2,460**	---	---	---	---	---	---	---
Nitrate	mg/L[d]	---	---	---	---	---	---	1.0UJ[e]	---	---	1.0U	---	---	---
Methane	µg/L	---	---	---	---	**1,200B,D[f]**	---	---	---	**3.4**	---	---	---	---
Acenaphthene	µg/L	---	---	10U	5U	---	---	---	---	---	---	---	10U	5U
Acenaphthylene	µg/L	---	---	10U	5U	---	---	---	---	---	---	---	10U	5U
Anthracene	µg/L	---	---	10U	0.5U	---	---	---	---	---	---	---	10U	0.5U
Benzidine	µg/L	---	---	100R[b]	---	---	---	---	---	---	---	---	100R	---
Benzo(a)anthracene	µg/L	---	---	10U	0.65U	---	---	---	---	---	---	---	10U	0.65U
Benzo(b)fluoranthene	µg/L	---	---	10U	0.9U	---	---	---	---	---	---	---	10U	0.9U
Benzo(g,h,i)perylene	µg/L	---	---	10U	1U	---	---	---	---	---	---	---	10U	1U
Benzo(k)fluoranthene	µg/L	---	---	10U	0.85U	---	---	---	---	---	---	---	10U	0.85U
Benzo(a)pyrene	µg/L	---	---	10U	1.2U	---	---	---	---	---	---	---	10U	1.2U
4-Bromophenyl phenyl ether	µg/L	---	---	10U	---	---	---	---	---	---	---	---	10U	---
Butyl benzyl phthalate	µg/L	---	---	10U	---	---	---	---	---	---	---	---	10U	---
bis (2-Chloroethoxy) methane	µg/L	---	---	10U	---	---	---	---	---	---	---	---	10U	---
bis (2-Chloroethyl) ether	µg/L	---	---	10U	---	---	---	---	---	---	---	---	10U	---
bis (2-Chloroisopropyl) ether	µg/L	---	---	10U	---	---	---	---	---	---	---	---	10U	---
4-Chloro-3-methylphenol	µg/L	---	---	10U	---	---	---	---	---	---	---	---	10U	---
2-Chloronaphthalene	µg/L	---	---	10U	---	---	---	---	---	---	---	---	10U	---
2-Chlorophenol	µg/L	---	---	10U	---	---	---	---	---	---	---	---	10U	---
4-Chlorophenyl phenyl ether	µg/L	---	---	10U	---	---	---	---	---	---	---	---	10U	---
Chlorobenzene	µg/L	0.5U	50U	---	---	---	---	---	0.5U	---	---	25U	---	---
Chrysene	µg/L	---	---	10U	1U	---	---	---	---	---	---	---	10U	1U
Dibenz(a,h)anthracene	µg/L	---	---	---	1.5UJ	---	---	---	---	---	---	---	---	1.5UJ
Di-n-butyl phthalate	µg/L	---	---	10U	---	---	---	---	---	---	---	---	10U	---
1,2-Dichlorobenzene	µg/L	0.5U	50U	10U	---	---	---	---	0.5U	---	---	25U	10U	---
1,3-Dichlorobenzene	µg/L	0.5U	50U	10U	---	---	---	---	0.5U	---	---	25U	10U	---
1,4-Dichlorobenzene	µg/L	0.5U	50U	10U	---	---	---	---	0.5U	---	---	25U	10U	---

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TABLE 5.3 (Continued)
SUMMARY OF GROUNDWATER ANALYTICAL DATA
Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina

		Sample Location, Date, and Method												
Analyte	Units	MPA 12/3/1998 602	MPB 12/3/1998 602	MPB 12/3/1998 625	MPB 12/3/1998 8310	MPB 12/3/1998 RSK-175	MPB 12/3/1998 EPH/VPH	MPB 12/3/1998 9056	MW2 12/3/1998 602	MW2 12/3/1998 RSK-175	MW2 12/3/1998 9056	MW4 12/3/1998 602	MW4 12/3/1998 625	MW4 12/3/1998 8310
3,3'-Dichlorobenzidine	µg/L	---	---	50R	---	---	---	---	---	---	---	---	50R	---
2,4-Dichlorophenol	µg/L	---	---	10U	---	---	---	---	---	---	---	---	10U	---
Diethyl phthalate	µg/L	---	---	10U	---	---	---	---	---	---	---	---	10U	---
2,4-Dimethylphenol	µg/L	---	---	**2.6J1**	---	---	---	---	---	---	---	---	**12**	---
Dimethyl phthalate	µg/L	---	---	10U	---	---	---	---	---	---	---	---	10U	---
2,4-Dinitrophenol	µg/L	---	---	50U	---	---	---	---	---	---	---	---	50U	---
2,4-Dinitrotoluene	µg/L	---	---	10U	---	---	---	---	---	---	---	---	10U	---
2,6-Dinitrotoluene	µg/L	---	---	10U	---	---	---	---	---	---	---	---	10U	---
Di-n-octyl phthalate	µg/L	---	---	10U	---	---	---	---	---	---	---	---	10U	---
1,2-Diphenylhydrazine	µg/L	---	---	10U	---	---	---	---	---	---	---	---	10U	---
bis (2-Ethylhexyl) phthalate	µg/L	---	---	10U	---	---	---	---	---	---	---	---	10U	---
Fluoranthene	µg/L	---	---	10U	1U	---	---	---	---	---	---	---	10U	1U
Fluorene	µg/L	---	---	10U	1U	---	---	---	---	---	---	---	10U	1U
Hexachlorobenzene	µg/L	---	---	10U	---	---	---	---	---	---	---	---	10U	---
Hexachlorobutadiene	µg/L	---	---	10U	---	---	---	---	---	---	---	---	10U	---
Hexachlorocyclopentadiene	µg/L	---	---	50J	---	---	---	---	---	---	---	---	50U	---
Hexachloroethane	µg/L	---	---	10U	---	---	---	---	---	---	---	---	10U	---
Indeno(1,2,3-cd)pyrene	µg/L	---	---	10U	2.2U	---	---	---	---	---	---	---	10U	2.2U
Isophorone	µg/L	---	---	10U	---	---	---	---	---	---	---	---	10U	---
MTBE	µg/L	**1.5F**	500U	---	---	---	---	---	5U	---	---	250U	---	---
Naphthalene	µg/L	---	---	**140**	**190**	---	---	---	---	---	---	---	**110**	**210**
Nitrobenzene	µg/L	---	---	10U	---	---	---	---	---	---	---	---	10U	---
2-Nitrophenol	µg/L	---	---	10U	---	---	---	---	---	---	---	---	10U	---
4-Nitrophenol	µg/L	---	---	50U	---	---	---	---	---	---	---	---	50U	---
N-Nitrosodimethylamine	µg/L	---	---	10U	---	---	---	---	---	---	---	---	10U	---
N-Nitrosodi-n-propylamine	µg/L	---	---	10U	---	---	---	---	---	---	---	---	10U	---
N-Nitrosodiphenylamine	µg/L	---	---	10J	---	---	---	---	---	---	---	---	10J	---
Pentachlorophenol	µg/L	---	---	50U	---	---	---	---	---	---	---	---	50U	---
Phenanthrene	µg/L	---	---	10U	1U	---	---	---	---	---	---	---	10U	1U
Phenol	µg/L	---	---	10U	---	---	---	---	---	---	---	---	10U	---
Pyrene	µg/L	---	---	10U	1U	---	---	---	---	---	---	---	10U	1U
1,2,4-Trichlorobenzene	µg/L	---	---	10U	---	---	---	---	---	---	---	---	10U	---
2,4,6-Trichlorophenol	µg/L	---	---	10U	---	---	---	---	---	---	---	---	10U	---

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TABLE 5.3 (Continued)
SUMMARY OF GROUNDWATER ANALYTICAL DATA
Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina

Analyte	Units	MW4 12/3/1998 RSK-175	MW4 12/3/1998 EPH/VPH	MW4 12/3/1998 9056	MW5 12/3/1998 602	MW5 12/3/1998 625	MW5 12/3/1998 8310	MW5 12/3/1998 RSK-175	MW5 12/3/1998 9056	MW6 12/2/1998 602	MW7 12/4/1998 602	MW8 12/4/1998 602
Benzene	μg/L [a]	---	---	---	0.5U	---	---	---	---	**570**	**5.8**	0.5U
Ethylbenzene	μg/L	---	---	---	0.5U	---	---	---	---	12U	**2.5**	0.5U
Toluene	μg/L	---	---	---	0.5U	---	---	---	---	12U	**5**	0.29U
Xylenes (total)	μg/L	---	---	---	0.5U	---	---	---	---	12U	**24**	0.5U
Aliphatics												
C5-C8	μg/L	---	**9,660**	---	---	---	---	---	---	---	---	---
C9-C18	μg/L	---	**2,513**	---	---	---	---	---	---	---	---	---
C19-C36	μg/L	---	100U	---	---	---	---	---	---	---	---	---
Aromatics												
C9-C22	μg/L	---	**1,795**	---	---	---	---	---	---	---	---	---
Nitrate	mg/L [d]	---	---	1.0U	---	---	---	---	0.41J1 [f]	---	---	---
Methane	μg/L	**1,700B,D**	---	---	---	---	---	0.31U	---	---	---	---
Acenaphthene	μg/L	---	---	---	---	10U	1U	---	---	---	---	---
Acenaphthylene	μg/L	---	---	---	---	10U	1U	---	---	---	---	---
Anthracene	μg/L	---	---	---	---	10U	0.1U	---	---	---	---	---
Benzidine	μg/L	---	---	---	---	100R	---	---	---	---	---	---
Benzo(a)anthracene	μg/L	---	---	---	---	10U	0.13U	---	---	---	---	---
Benzo(b)fluoranthene	μg/L	---	---	---	---	10U	0.18U	---	---	---	---	---
Benzo(g,h,i)perylene	μg/L	---	---	---	---	10U	0.2U	---	---	---	---	---
Benzo(k)fluoranthene	μg/L	---	---	---	---	10U	0.17U	---	---	---	---	---
Benzo(a)pyrene	μg/L	---	---	---	---	10U	0.23U	---	---	---	---	---
4-Bromophenyl phenyl ether	μg/L	---	---	---	---	10U	---	---	---	---	---	---
Butyl benzyl phthalate	μg/L	---	---	---	---	10U	---	---	---	---	---	---
bis (2-Chloroethoxy) methane	μg/L	---	---	---	---	10U	---	---	---	---	---	---
bis (2-Chloroethyl) ether	μg/L	---	---	---	---	10U	---	---	---	---	---	---
bis (2-Chloroisopropyl) ether	μg/L	---	---	---	---	10U	---	---	---	---	---	---
4-Chloro-3-methylphenol	μg/L	---	---	---	---	10U	---	---	---	---	---	---
2-Chloronaphthalene	μg/L	---	---	---	---	10U	---	---	---	---	---	---
2-Chlorophenol	μg/L	---	---	---	---	10U	---	---	---	---	---	---
4-Chlorophenyl phenyl ether	μg/L	---	---	---	---	10U	---	---	---	---	---	---
Chlorobenzene	μg/L	---	---	---	0.5U	---	---	---	---	12U	0.5U	0.5U
Chrysene	μg/L	---	---	---	---	10U	0.2U	---	---	---	---	---
Dibenz(a,h)anthracene	μg/L	---	---	---	---	---	0.3U	---	---	---	---	---
Di-n-butyl phthalate	μg/L	---	---	---	---	10U	---	---	---	---	---	---
1,2-Dichlorobenzene	μg/L	---	---	---	0.5U	10U	---	---	---	12U	0.5U	0.5U
1,3-Dichlorobenzene	μg/L	---	---	---	0.5U	10U	---	---	---	12U	0.5U	0.5U
1,4-Dichlorobenzene	μg/L	---	---	---	0.5U	10U	---	---	---	12U	0.5U	0.5U

TABLE 5.3 (Continued)
SUMMARY OF GROUNDWATER ANALYTICAL DATA
Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina

Analyte	Units	MW4 12/3/1998 RSK-175	MW4 12/3/1998 EPH/VPH	MW4 12/3/1998 9056	MW5 12/3/1998 602	MW5 12/3/1998 625	MW5 12/3/1998 8310	MW5 12/3/1998 RSK-175	MW5 12/3/1998 9056	MW6 12/2/1998 602	MW7 12/4/1998 602	MW8 12/4/1998 602
3.3'-Dichlorobenzidine	µg/L	---	---	---	---	50R	---	---	---	---	---	---
2,4-Dichlorophenol	µg/L	---	---	---	---	10U	---	---	---	---	---	---
Diethyl phthalate	µg/L	---	---	---	---	10U	---	---	---	---	---	---
2,4-Dimethylphenol	µg/L	---	---	---	---	10U	---	---	---	---	---	---
Dimethyl phthalate	µg/L	---	---	---	---	10U	---	---	---	---	---	---
2,4-Dinitrophenol	µg/L	---	---	---	---	50U	---	---	---	---	---	---
2,4-Dinitrotoluene	µg/L	---	---	---	---	10U	---	---	---	---	---	---
2,6-Dinitrotoluene	µg/L	---	---	---	---	10U	---	---	---	---	---	---
Di-n-octyl phthalate	µg/L	---	---	---	---	10U	---	---	---	---	---	---
1,2-Diphenylhydrazine	µg/L	---	---	---	---	10U	---	---	---	---	---	---
bis (2-Ethylhexyl) phthalate	µg/L	---	---	---	---	10U	---	---	---	---	---	---
Fluoranthene	µg/L	---	---	---	---	10U	0.2U	---	---	---	---	---
Fluorene	µg/L	---	---	---	---	10U	0.2U	---	---	---	---	---
Hexachlorobenzene	µg/L	---	---	---	---	10U	---	---	---	---	---	---
Hexachlorobutadiene	µg/L	---	---	---	---	10U	---	---	---	---	---	---
Hexachlorocyclopentadiene	µg/L	---	---	---	---	50U	---	---	---	---	---	---
Hexachloroethane	µg/L	---	---	---	---	10U	---	---	---	---	---	---
Indeno(1,2,3-cd)pyrene	µg/L	---	---	---	---	10U	0.43U	---	---	---	---	---
Isophorone	µg/L	---	---	---	---	10U	---	---	---	---	---	---
MTBE	µg/L	---	---	---	**0.22F**	---	---	---	---	120U	5U	5U
Naphthalene	µg/L	---	---	---	---	10U	1U	---	---	---	---	---
Nitrobenzene	µg/L	---	---	---	---	10U	---	---	---	---	---	---
2-Nitrophenol	µg/L	---	---	---	---	10U	---	---	---	---	---	---
4-Nitrophenol	µg/L	---	---	---	---	50U	---	---	---	---	---	---
N-Nitrosodimethylamine	µg/L	---	---	---	---	10U	---	---	---	---	---	---
N-Nitrosodi-n-propylamine	µg/L	---	---	---	---	10U	---	---	---	---	---	---
N-Nitrosodiphenylamine	µg/L	---	---	---	---	10J	---	---	---	---	---	---
Pentachlorophenol	µg/L	---	---	---	---	50U	---	---	---	---	---	---
Phenanthrene	µg/L	---	---	---	---	10U	0.2U	---	---	---	---	---
Phenol	µg/L	---	---	---	---	10U	---	---	---	---	---	---
Pyrene	µg/L	---	---	---	---	10U	0.2U	---	---	---	---	---
1,2,4-Trichlorobenzene	µg/L	---	---	---	---	10U	---	---	---	---	---	---
2,4,6-Trichlorophenol	µg/L	---	---	---	---	10U	---	---	---	---	---	---

Note: Shaded areas denote all detectable concentrations. Non detects are not shaded.
a/ µg/L = Micrograms per liter.
b/ --- = Not analyzed.
c/ U = The analyte was analyzed for and is not present above the associated reporting limit shown.
d/ mg/L = Milligrams per liter.
e/ J = The analyte was positively identified, but the value may not be representative of what is actually present.
f/ J1 = This is an estimated result. The analyte was positively identified and has a concentration between the method detection limit and the reporting limit.
g/ B = Method blank contamination. The associated method blank contains the target analyte at a reportable limit.. D = Result was obtained from the analysis of a dilution.
h/ R = Analyte is rejected, presence of the analyte was not verified.

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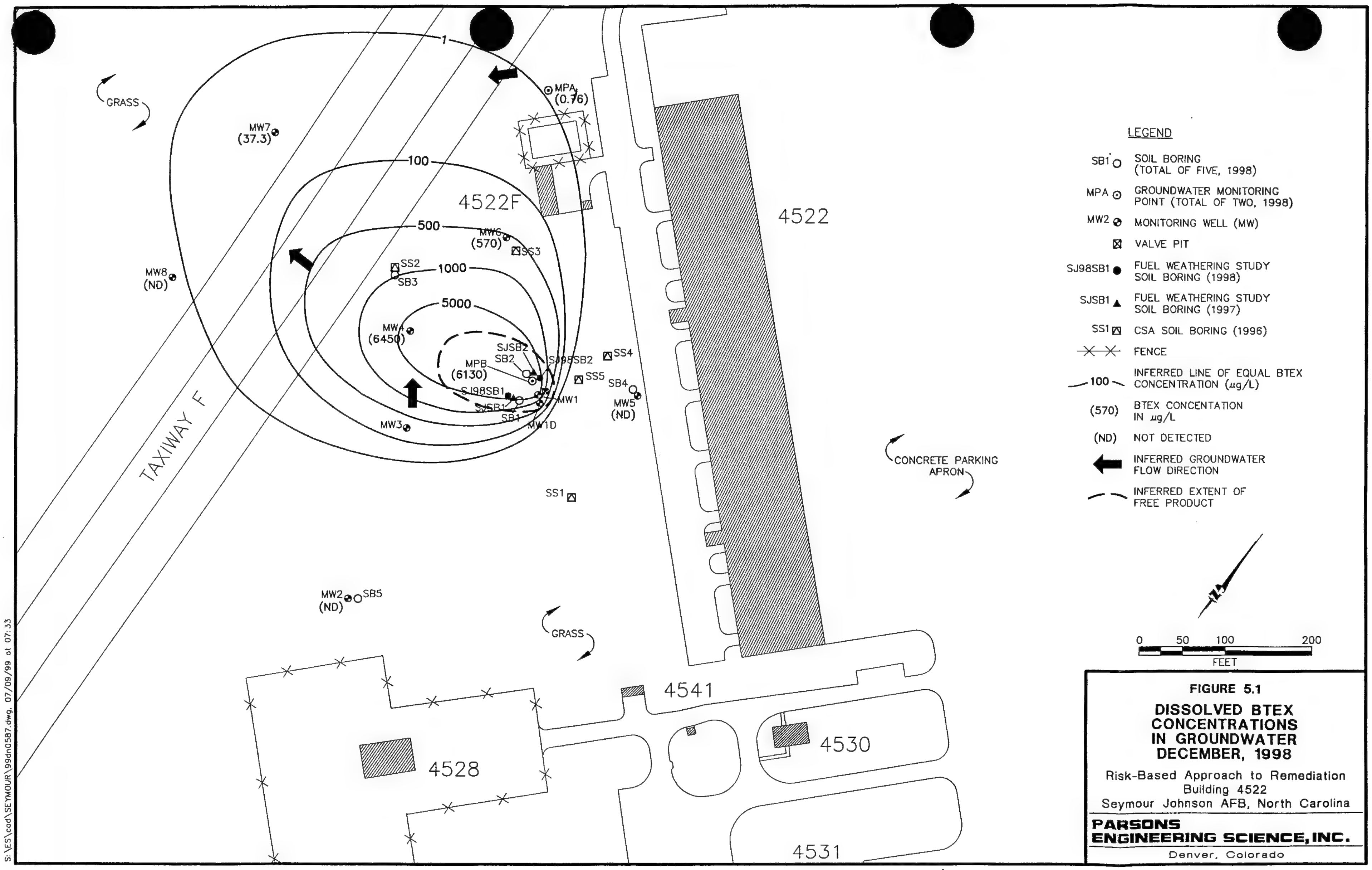

FIGURE 5.1

DISSOLVED BTEX CONCENTRATIONS IN GROUNDWATER DECEMBER, 1998

Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

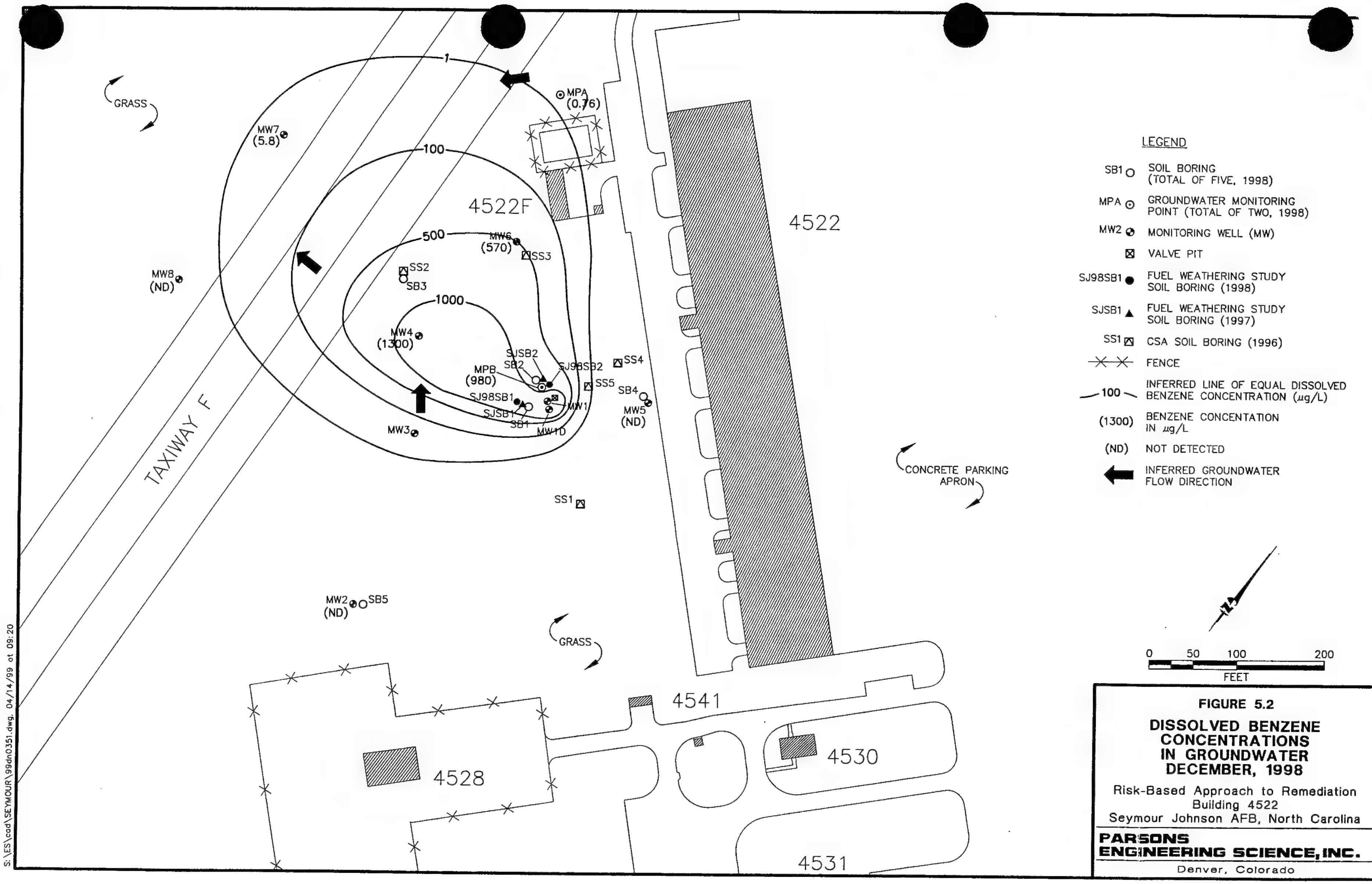

FIGURE 5.2

DISSOLVED BENZENE CONCENTRATIONS IN GROUNDWATER DECEMBER, 1998

Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

TABLE 5.4
SUMMARY OF SURFACE WATER ANALYTICAL DATA
Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina

		Sample Locations and Dates	
		SW1	SW2
Analyte	Units[a/]	12/4/1998	12/4/1998
Benzene	μg/L	0.5U[b/]	0.5U
Toluene	μg/L	0.5U	0.5U
Ethylbenzene	μg/L	0.5U	0.5U
Xylenes (total)	μg/L	0.5U	0.5U

a/ ug/L = micrograms per liter.

b/ U = the analyte was analyzed for and and is not present above the associated reporting limit.

TABLE 5.5
SUMMARY OF SOIL GAS ANALYTICAL DATA
Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina

	Sample Locations, Dates, and Units	
	SG1 5-Dec-98	
Analyte	ppmv [a/]	µg/L [b/]
Benzene	260	860
Toluene	59	220
Ethylbenzene	32	140
Xylenes (total)	110 M[c/]	480 M
TPH (C2+ Hydrocarbons) [d/]	110000 B[e/]	710000 B

a/ ppmv = parts per million, volume per volume.

b/ µg/L = micrograms per liter.

c/ M = Reported value may be biased due to apparent matrix interferences.

d/ TPH = Total petroleum hydrocarbons, referenced to JP5 jet fuel.

e/ B = Method blank contamination. The associated method blank contains the target analyte at a reportable level.

SECTION 6

CHEMICAL FATE ASSESSMENT

6.1 INTRODUCTION

Biodegradation of dissolved fuel constituents and the future migration and persistence of the dissolved contaminants identified in Section 4 are assessed in this section.

As used throughout this report, the term "remediation by natural attenuation" (RNA) refers to a subsurface contaminant remediation strategy that relies on natural physical, chemical, and biological mechanisms to control exposure of potential receptors to concentrations of contaminants in soil and groundwater that exceed regulatory levels. These mechanisms include the processes of advection, hydrodynamic dispersion, dilution from recharge, sorption, volatilization, and biodegradation, which facilitate RNA of a variety of anthropogenic chemicals.

This section summarizes and interprets specific site characterization data relevant to documenting the effectiveness of RNA at minimizing dissolved contaminant migration and reducing contaminant concentration, mass, and toxicity over time. This assessment was used to determine whether natural attenuation may be a useful component of a cost-effective remedial approach for the site.

6.2 OPERATIVE MECHANISMS OF CONTAMINANT ATTENUATION

Understanding the fate of COPCs in environmental media is critical to evaluating and predicting contaminant distribution patterns. There are several physical, chemical, and biological processes that influence how a chemical behaves in soil and groundwater. These processes must be evaluated when determining whether some type of remediation is warranted because chemical contamination poses or has the potential to pose a risk to human or ecological receptors. If contamination cannot reach a potential receptor exposure point, the contamination poses no risk.

Nondestructive attenuation processes can be described as those physical and chemical processes that may prohibit significant contaminant migration but will not result in a permanent reduction in contaminant mass. Examples of nondestructive attenuation processes include volatilization, sorption, dilution from recharge, advection, and hydrodynamic dispersion.

In comparison to nondestructive chemical attenuation processes, destructive chemical attenuation processes result in the permanent removal of contaminant mass from the environment. Documenting and distinguishing the effects of destructive attenuation processes, such as biodegradation, from nondestructive attenuation processes is critical to

evaluating the potential for RNA to bring about a reduction in contaminant mass over time. The effectiveness of destructive attenuation processes at reducing contaminant mass at a site depends on how susceptible the chemical is to biodegradation and whether the site is characterized by physical, chemical, and biological conditions favorable to such processes.

Numerous laboratory and field studies have shown that hydrocarbon-degrading bacteria can participate in the degradation of many of the chemical components of different types of fuels (e.g., jet fuel) under both aerobic and anaerobic conditions. Biodegradation of fuel hydrocarbons will occur when an indigenous population of hydrocarbon-degrading microorganisms is present in the soil and groundwater, and sufficient concentrations of electron acceptors and nutrients, including fuel hydrocarbons, are available to these organisms. Soil and groundwater with a history of exposure to fuel hydrocarbon compounds, such as at the Building 4522 site, generally contain microbial populations capable of facilitating biodegradation reactions (Wiedemeier *et al.,* 1995). The chemical basis for the biodegradation of BTEX is described in more detail in Section 6.4, where geochemical data relevant to documenting biodegradation at the field scale at the site are presented.

6.3 EVIDENCE OF CONTAMINANT REDUCTION OVER TIME

The first step in determining whether contaminant concentrations are being reduced in soil and groundwater at the site was to compare contaminant concentrations at selected sampling locations over time. The purpose of this comparison is to assess the evidence of field-scale contaminant mass loss. Decreases in the magnitude of contaminant concentrations at a site over time that cannot be explained by physical processes (e.g., source removal actions such as SVE, air sparging, mass transport in groundwater) may be the first indication that contaminants are biodegrading at the site.

6.3.1 VOC Concentration Trends in Soil

December 1998 soil contamination data are compared to historical soil contamination data to assess the effects of biodegradation. In 1996, 1997, and 1998, soil samples were collected at various locations as shown on Figure 2.1. The historical laboratory analytical data are compared in Table 6.1 to the analytical results for the December 1998 soil samples. The data suggest that soil contaminant concentrations in the vadose zone have been substantially reduced since 1996 due to the effects of biodegradation and volatilization. However, the soil samples were not all collected at the same depths; therefore, the degree to which natural attenuation is responsible for the observed decreases (as opposed to the spatial distribution of soil contamination) is not known.

6.3.2 BTEX Concentration Trends in Groundwater

BTEX and naphthalene concentrations measured at select monitoring wells from April 1996 to December 1998 are summarized in Table 6.2, and the BTEX concentrations measured in MW4 are shown on Figure 6.1. This well is located downgradient from the spill locations, and has historically evidenced the highest dissolved BTEX concentrations at the site. The measured decrease in dissolved BTEX concentrations suggests that the source (free and residual product) is weathering. First-order degradation rates were

TABLE 6.1
SUMMARY OF HISTORICAL COPC CONCENTRATIONS IN SOIL
Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina

BORING	DEPTH (bgs)[a]	DATE	UNITS	BENZENE	TOLUENE	ETHYLBENZENE	TOTAL XYLENES
SJSB1	5.5'	May-97	mg/kg[b]	10.8	64.7	56.1	292.3
SJ98SB1	3'	Mar-98	mg/kg	3.1	17.2	24.3	101.5
SB1	2.5'	Dec-98	mg/kg	0.56U[c]	2.7	3.6	20.1

BORING	DEPTH (bgs)	DATE	UNITS	BENZENE	TOLUENE	ETHYLBENZENE	TOTAL XYLENES
SJSB2	5.5'	May-97	mg/kg	12.5	56.3	75.3	416.1
SJ98SB2	3'	Mar-98	mg/kg	3.5	34.6	54.1	208.4
SB2	4'	Dec-98	mg/kg	2.3 UJ [d]	2.1 J	6.4 J	31.1

BORING	DEPTH (bgs)	DATE	UNITS	TPH Gasoline Range	TPH Kerosene Range	VPH/EPH C5-C8	VPH/EPH C9-C18	VPH/EPH C19-C36	VPH/EPH C9-C22
SS2	4.5'	Apr-96	mg/kg	ND[e]	511.0	---[f]	---	---	---
SB3	6'	Dec-98	mg/kg	---	---	27.7	108.0	10.6	72.1

[a] bgs = Below ground surface.
[b] mg/kg = Milligrams per kilogram.
[c] U = The analyte was analyzed for and is not present above the associated reporting limit.
[d] J = The analyte was positively identified, but the value may not be representative of what is actually present.
[e] ND = Not detected.
[f] --- = Not analyzed.

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TABLE 6.2
SUMMARY OF HISTORICAL COPC CONCENTRATIONS IN GROUNDWATER
Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina

WELL	DATE	BENZENE (μg/L)[a]	TOLUENE (μg/L)	ETHYLBENZENE (μg/L)	TOTAL XYLENES (μg/L)	TOTAL BTEX (μg/L)	NAPHTHALENE (μg/L)
MW1	Apr-96	NSP[b]	NSP	NSP	NSP	NSP	NSP
SJMP1[c]	May-97	848	4,100	842	3,238	9,208	254
SJMW1S[c]	May-97	566	1,600	635	2,032	4,833	211
SJ98MP1[c]	Mar-98	833	2,896	587	2,492	6,808	247
MPB[c]	Dec-98	980	2,900	450	1,800	6,130	190

WELL	DATE	BENZENE (μg/L)	TOLUENE (μg/L)	ETHYLBENZENE (μg/L)	TOTAL XYLENES (μg/L)	TOTAL BTEX (μg/L)	NAPHTHALENE (μg/L)
MW2	Apr-96	1.0U[d]	1.0U	1.0U	1.0U	ND[e]	1.0U
	Dec-98	0.5U	0.5U	0.5U	0.5U	ND	---[f]

WELL	DATE	BENZENE (μg/L)	TOLUENE (μg/L)	ETHYLBENZENE (μg/L)	TOTAL XYLENES (μg/L)	TOTAL BTEX (μg/L)	NAPHTHALENE (μg/L)
MW4	Apr-96	1,400	3,700	730	2,900	8,730	120
	Dec-98	1,300	2,200	650	2,300	6,450	210

WELL	DATE	BENZENE (μg/L)	TOLUENE (μg/L)	ETHYLBENZENE (μg/L)	TOTAL XYLENES (μg/L)	TOTAL BTEX (μg/L)	NAPHTHALENE (μg/L)
MW5	Apr-96	1.0U	1.0U	1.0U	1.0U	ND	1.0U
	Dec-98	0.5U	0.5U	0.5U	0.5U	ND	10U

WELL	DATE	BENZENE (μg/L)	TOLUENE (μg/L)	ETHYLBENZENE (μg/L)	TOTAL XYLENES (μg/L)	TOTAL BTEX (μg/L)	NAPHTHALENE (μg/L)
MW6	Jul-96	460	5.0U	5.0U	10.0U	460	12.0
	Dec-98	570	12.0U	12.0U	12.0U	570	---

WELL	DATE	BENZENE (μg/L)	TOLUENE (μg/L)	ETHYLBENZENE (μg/L)	TOTAL XYLENES (μg/L)	TOTAL BTEX (μg/L)	NAPHTHALENE (μg/L)
MW7	Jul-96	2.0	1.0U	1.0	2.0U	3	1.0U
	Dec-98	5.8	5	2.5	24.0	37.3	---

WELL	DATE	BENZENE (μg/L)	TOLUENE (μg/L)	ETHYLBENZENE (μg/L)	TOTAL XYLENES (μg/L)	TOTAL BTEX (μg/L)	NAPHTHALENE (μg/L)
MW8	Jul-96	1.0U	2	1.0U	2.0U	2	1.0U
	Dec-98	0.5U	0.29 U	0.5U	0.5U	0.29	---

a/ μg/L = Micrograms per liter.
b/ NSP = Not sampled due the presence of free product in the well.
c/ All of these sampling locations are in the vicinity of MW1, refer to Figure 5.1.
d/ U = The analyte was analyzed for and is not present above the associated reporting limit shown.
e/ ND = Non detect.
f --- = Not analyzed.

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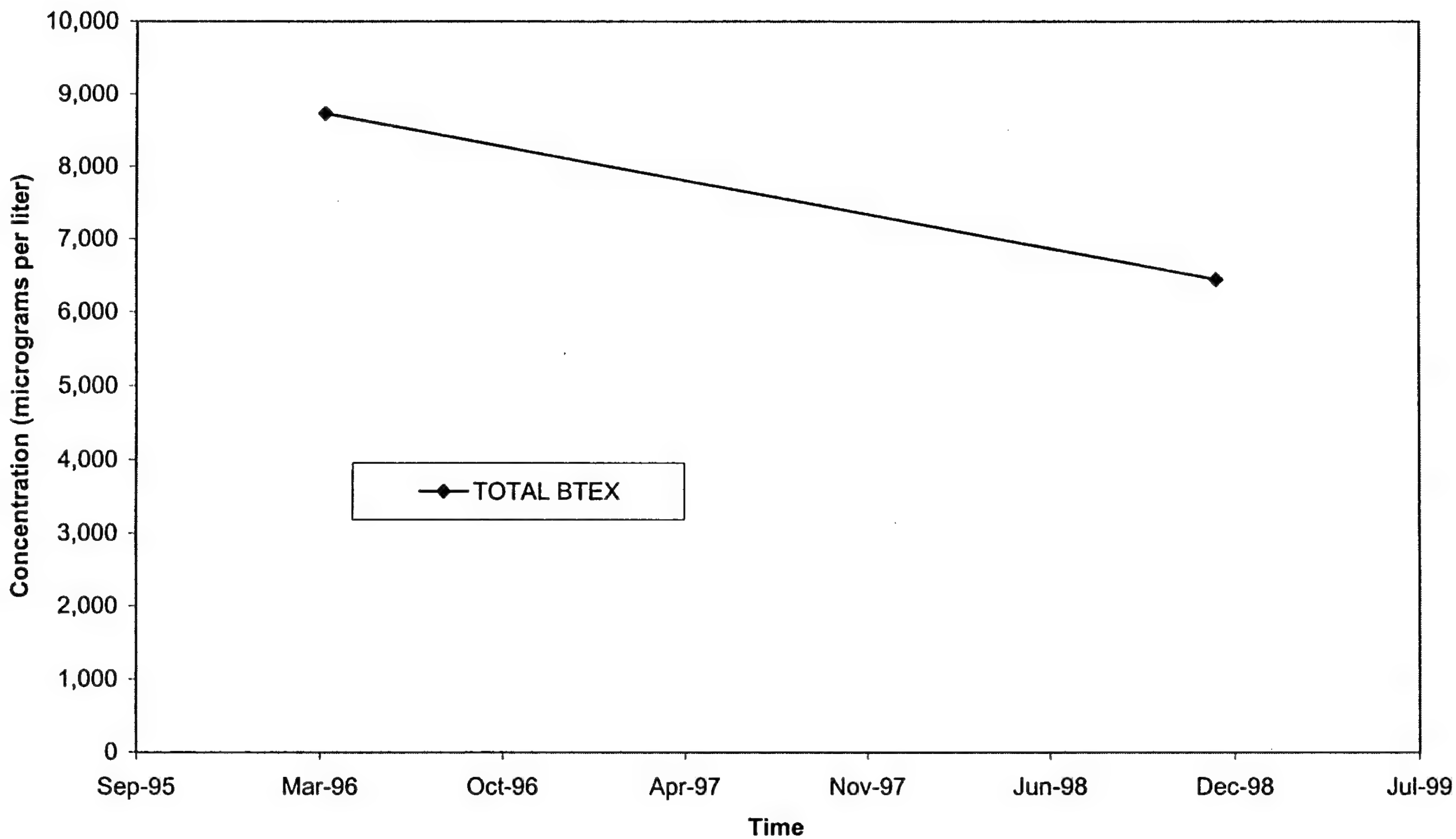
FIGURE 6.1
DISSOLVED COPC CONCENTRATIONS VS TIME AT MW4
Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina



estimated for BTEX and benzene using site-specific data and the Method of Buscheck and Alcantar (1995). A detailed discussion of the first-order degradation rate calculations is provided in Appendix E. Buscheck and Alcantar (1995) derive a relationship that allows calculation of first-order biodegradation rate constants for steady-state plumes. This method involves coupling the regression of contaminant concentration (plotted on a logarithmic scale) versus distance downgradient (plotted on a linear scale) to an analytical solution for one-dimensional, steady-state, contaminant transport that includes advection, dispersion, sorption, and biodegradation (Bear, 1979).

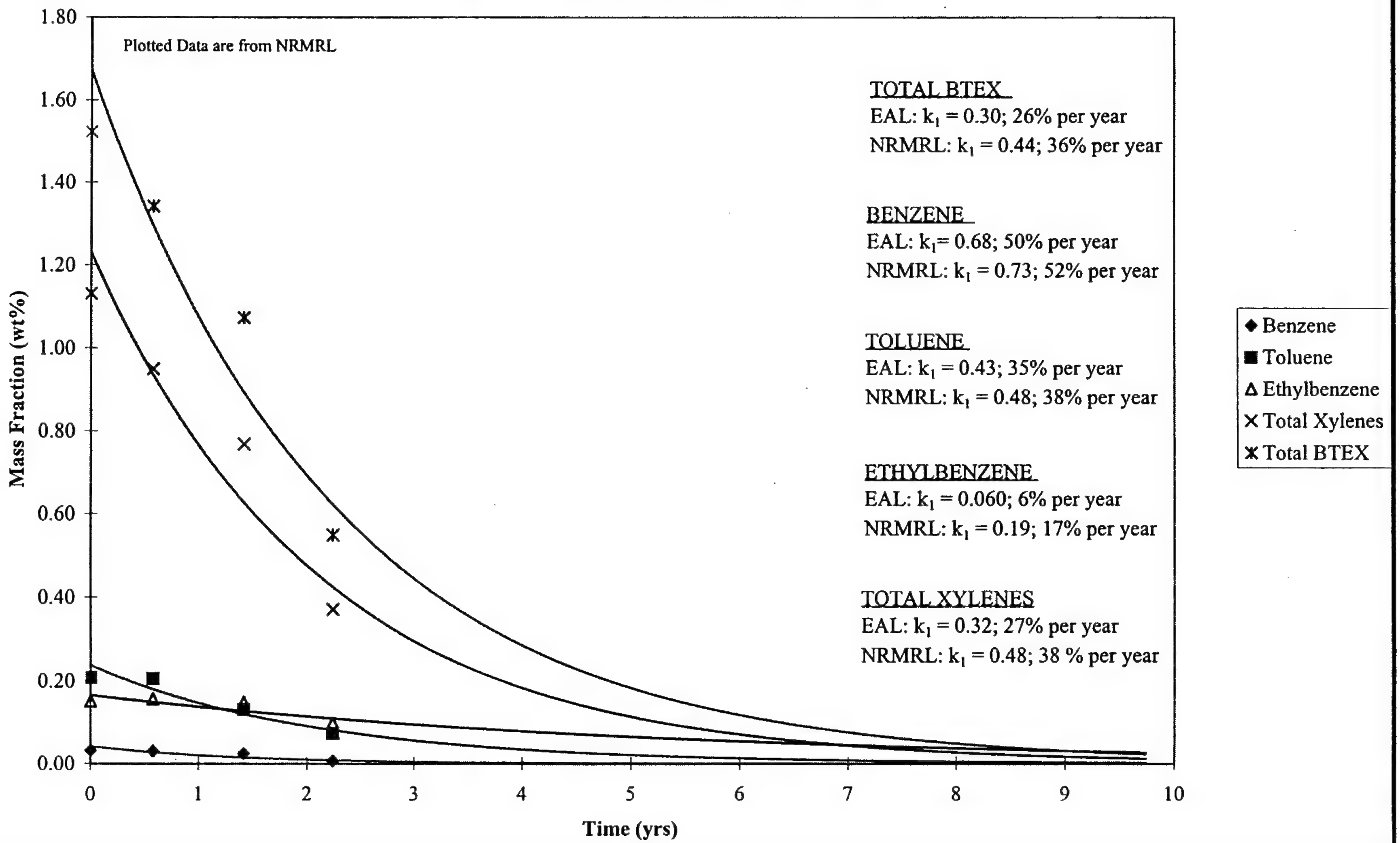
The calculated rates for BTEX and benzene attenuation were 0.0026 day^{-1} (half-life of 0.7 year) and 0.0049 day^{-1} (half-life of 0.4 year), respectively. These rates are very similar to the BTEX degradation rate of 0.0035 day^{-1} (half-life of 0.5 year) used in the calibrated numerical groundwater flow and fate and transport model constructed for the former AGE Fueling Facility on Seymour Johnson AFB (Parsons ES, 1996). The benzene degradation rates computed for the former AGE fueling facility ranged from 1.6×10^{-3} day^{-1} (half-life of 1.2 years) to 3.6×10^{-3} (half-life of 0.5 year). The higher rate (3.6×10^{-3} day^{-1}) was computed using the conservative tracer (trimethylbenzene) method described in Wiedemeier *et al.* (1995). This method does not require the presence of steady-state plume conditions (which may not have been present during the investigation of this site in 1995) and therefore may be more accurate. The hydrogeologic conditions at the former AGE Fueling Facility are similar to those observed at the Building 4522 site (shallow silty sand aquifer contaminated with fuel).

6.3.3 BTEX Concentration Trends in Free Product

Parsons ES also evaluated the natural weathering of light nonaqueous-phase liquids (LNAPLs) (free product) resulting from petroleum releases to the subsurface environment. The primary objective of this AFCEE study was to document a range of BTEX weathering rates for free product based on data collected from sites with documented free product plumes with known release dates. The Building 4522 site was included in the study. Product samples were analyzed at two different laboratories, including Evergreen Analytical Laboratory (EAL) and the USEPA National Risk Management Research Laboratory (NRMRL).

The weathering of BTEX from LNAPL via dissolution and volatilization is expected to follow first-order kinetics, which predicts that the rate of BTEX removal from the free-phase will be reduced as the concentrations of BTEX in the free-phase decrease over time. The average total first-order BTEX weathering rate for five JP-4 contaminated sites is approximately 16 percent per year, with a reasonable range of 11 to 23 percent per year. Figure 6.2 suggests that first-order reduction for BTEX compounds at the Building 4522 site is occurring at 6 to 52 percent per year. The first-order decay rates for total BTEX ranged from 26 to 36 percent per year. Compound-specific reduction rates are highest for benzene (the most soluble of the BTEX compounds), followed by toluene, xylenes, and ethylbenzene (the least soluble of the BTEX compounds).

FIGURE 6.2
FIRST-ORDER BTEX WEATHERING IN JP-8 MOBILE LNAPL AT MW-1S
BUILDING 4522
SEYMOUR JOHNSON AFB, NORTH CAROLINA



022/731854/SJ/Figure 6.3 Chart 2

6.4 EVIDENCE OF CONTAMINANT BIODEGRADATION VIA MICROBIALLY MEDIATED REDOX REACTIONS

Fuel hydrocarbons are typically utilized as electron donors in biologically mediated redox reactions under a wide range of geochemical conditions. Therefore, analytical data on potential electron acceptors can be used as geochemical indicators of fuel hydrocarbon biodegradation (Wiedemeier *et al.*, 1995). Reductions in the concentrations of oxidized chemical species that are used by microorganisms to facilitate the oxidation of fuel hydrocarbon compounds within contaminated media are an indication that contaminants are biodegrading. Alternately, an increase in the metabolic byproducts resulting from the reduction of electron acceptors can be used as an indicator of contaminant biodegradation. The availability of potential electron acceptors to participate in contaminant biodegradation reactions can be used to estimate the total contaminant mass that can be biodegraded over time at this site. This information can be used to predict how much dissolved COPC mass can be removed from saturated soil and groundwater at the site as a result of natural processes.

6.4.1 Relevance of Redox Couples in Biodegradation

Microorganisms obtain energy to replenish enzymatic systems and to reproduce by oxidizing organic matter. Biodegradation of dissolved fuel hydrocarbons is the result of a series of redox reactions that maintain the charge balance within the natural environment. Microorganisms facilitate the degradation of these organic compounds by transferring electrons from the electron donor (i.e., fuel hydrocarbons and native organic carbon) to available electron acceptors. Electron acceptors are elements or compounds that occur in relatively oxidized states and can participate in redox reactions involving these available electron donors. Electron acceptors known to be present in saturated soil and groundwater at the site are oxygen, nitrate/nitrogen, sulfate, ferric iron, and carbon dioxide.

Microorganisms facilitate fuel hydrocarbon biodegradation to produce energy for their use. The amount of energy that can be released when a reaction occurs or is required to drive the reaction to completion is quantified by the free energy of the reaction (Stumm and Morgan, 1981). Microorganisms are able to utilize electron transport systems and chemiosmosis to combine energetically favorable and unfavorable reactions to produce energy for life processes (i.e., cell production and maintenance). Microorganisms will facilitate only those redox reactions that will yield energy. By coupling the oxidation of fuel hydrocarbon compounds, which requires energy, to the reduction of other compounds (e.g., oxygen, nitrate/nitrite, manganese, ferric iron, sulfate, and carbon dioxide), which yields energy, the overall reaction will yield energy. Detailed information on the redox reactions required to biodegrade dissolved COPCs is included in Table 6.3.

Figure 6.3 illustrates the sequence of microbially mediated redox processes based on the amount of free energy released for microbial use. In general, reactions yielding more energy tend to take precedence over processes that yield less energy (Stumm and Morgan, 1981). As Figure 6.3 shows, oxygen reduction would be expected to occur in an aerobic environment with microorganisms capable of aerobic respiration because oxygen reduction yields significant energy. However, once the available oxygen is depleted and

TABLE 6.3
COUPLED OXIDATION REACTIONS
Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina

Coupled Benzene Oxidation Reactions	ΔG°r (kcal/mole Benzene)	ΔG°r (kJ/mole Benzene)	Stoichiometric Mass Ratio of Electron Acceptor to Compound
$7.5 O_2 + C_6H_6 \Rightarrow 6 CO_{2,g} + 3 H_2O$ *Benzene oxidation /aerobic respiration*	-765.34	-3202	3.07:1
$6 NO_3^- + 6 H^+ + C_6H_6 \Rightarrow 6 CO_{2,g} + 6 H_2O + 3 N_{2,g}$ *Benzene oxidation / denitrification*	-775.75	-3245	4.77:1
$30 H^+ + 15 \underline{MnO_2} + C_6C_6 \Rightarrow 6 CO_{2,g} + 15 Mn^{2+} + 18 H_2O$ *Benzene oxidation / manganese reduction*	-765.45	-3202	10.56:1
$60 H^+ + 30 \underline{Fe(OH)_{3,a}} + C_6H_6 \Rightarrow 6 CO_2 + 30 Fe^{2+} + 78 H_2O$ *Benzene oxidation / iron reduction*	-560.10	-2343	21.5:1[a/]
$7.5 H^+ + 3.75 SO_4^{2-} + C_6H_6 \Rightarrow 6 CO_{2,g} + 3.75 H_2S^{\circ} + 3 H_2O$ *Benzene oxidation / sulfate reduction*	-122.93	-514.3	4.61:1
$4.5 H_2O + C_6H_6 \Rightarrow 2.25 CO_{2,g} + 3.75 CH_4$ *Benzene oxidation / methanogenesis*	-32.40	-135.6	0.77:1 [b/]

Coupled Toluene Oxidation Reactions	ΔG°r (kcal/mole Toluene)	ΔG°r (kJ/mole Toluene)	Stoichiometric Mass Ratio of Electron Acceptor to Compound
$9 O_2 + C_6H_5CH_3 \Rightarrow 7 CO_{2,g} + 4 H_2O$ *Toluene oxidation /aerobic respiration*	-913.76	-3823	3.13:1
$7.2 NO_3^- + 7.2 H^+ + C_6H_5CH_3 \Rightarrow 7 CO_{2,g} + 7.6 H_2O + 3.6 N_{2,g}$ *Toluene oxidation / denitrification*	-926.31	-3875	4.85:1
$36 H^+ + 18 \underline{MnO_2} + C_6H_5CH_3 \Rightarrow 7 CO_{2g} + 18 Mn^{2+} + 22 H_2O$ *Toluene oxidation / manganese reduction*	-913.89	-3824	10.74:1
$72 H^+ + 36 \underline{Fe(OH)_{3,a}} + C_6H_5CH_3 \Rightarrow 7 CO_2 + 36 Fe^{2+} + 94 H_2O$ *Toluene oxidation / iron reduction*	-667.21	-2792	21.86:1[a/]
$9 H^+ + 4.5 SO_4^{2-} + C_6H_5CH_3 \Rightarrow 7 CO_{2,g} + 4.5 H_2S^{\circ} + 4 H_2O$ *Toluene oxidation / sulfate reduction*	-142.86	-597.7	4.7:1
$5 H_2O + C_6H_5CH_3 \Rightarrow 2.5 CO_{2,g} + 4.5 CH_4$ *Toluene oxidation / methanogenesis*	-34.08	-142.6	0.78:1 [b/]

TABLE 6.3 (Continued)
COUPLED OXIDATION REACTIONS
Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina

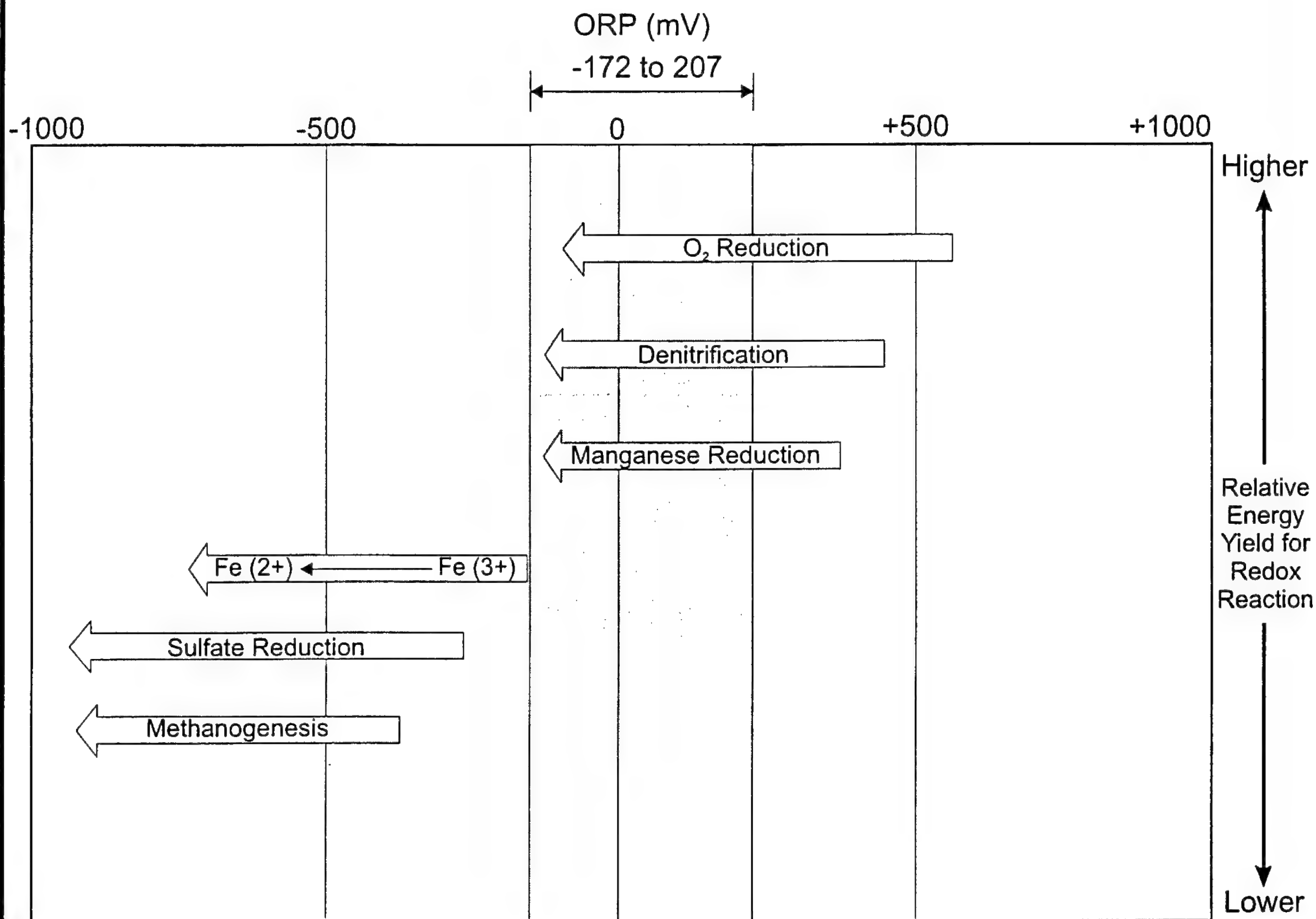
Coupled Ethylbenzene Oxidation Reactions	$\Delta G°_r$ (kcal/mole Ethyl-benzene)	$\Delta G°_r$ (kJ/mole Ethyl-benzene)	Stoichiometric Mass Ratio of Electron Acceptor to Compound
$10.5O_2 + C_6H_5C_2H_5 \Rightarrow 8CO_{2,g} + 5H_2O$ *Ethylbenzene oxidation /aerobic respiration*	-1066.13	-4461	3.17:1
$8.4NO_3^- + 8.4H^+ + C_6H_5C_2H_5 \Rightarrow 8CO_{2,g} + 9.2H_2O + 4.2N_{2,g}$ *Ethylbenzene oxidation / denitrification*	-1080.76	-4522	4.92:1
$42H^+ + 21MnO_2 + C_6H_5C_2H_5 \Rightarrow 8CO_{2g} + 21Mn^{2+} + 26H_2O$ *Ethylbenzene oxidation / manganese reduction*	-1066.27	-4461	17.24:1
$84H^+ + 42Fe(OH)_{3,a} + C_6H_5C_2H_5 \Rightarrow 8CO_2 + 42Fe^{2+} + 110H_2O$ *Ethylbenzene oxidation / iron reduction*	-778.48	-3257	22:1[a/]
$10.5H^+ + 5.25SO_4^{2-} + C_6H_5C_2H_5 \Rightarrow 8CO_{2,g} + 5.25H_2S° + 5H_2O$ *Ethylbenzene oxidation / sulfate reduction*	-166.75	-697.7	4.75:1
$5.5H_2O + C_6H_5C_2H_5 \Rightarrow 2.75CO_{2,g} + 5.25CH_4$ *Ethylbenzene oxidation / methanogenesis*	-39.83	-166.7	0.79:1 [b/]

Coupled m-Xylene Oxidation Reactions	$\Delta G°_r$ (kcal/mole *m*-xylene)	$\Delta G°_r$ (kJ/mole *m*-xylene)	Stoichiometric Mass Ratio of Electron Acceptor to Compound
$10.5O_2 + C_6H_4(CH_3)_2 \Rightarrow 8CO_{2,g} + 5H_2O$ *m-Xylene oxidation /aerobic respiration*	-1063.25	-4448	3.17:1
$8.4NO_3^- + 8.4H^+ + C_6H_4(CH_3)_2 \Rightarrow 8CO_{2,g} + 9.2H_2O + 4.2N_{2,g}$ *m-Xylene oxidation / denitrification*	-1077.81	-4509	4.92:1
$42H^+ + 21MnO_2 + C_6H_5C_2H_5 \Rightarrow 8CO_{2g} + 21Mn^{2+} + 26H_2O$ *m-Xylene oxidation / manganese reduction*	-1063.39	-4449	17.24:1
$84H^+ + 42Fe(OH)_{3,a} + C_6H_4(CH_3)_2 \Rightarrow 8CO_2 + 42Fe^{2+} + 110H_2O$ *m-Xylene oxidation / iron reduction*	-775.61	-3245	22:1[a/]
$10.5H^+ + 5.25SO_4^{2-} + C_6H_4(CH_3)_2 \Rightarrow 8CO_{2,g} + 5.25H_2S° + 5H_2O$ *m-Xylene oxidation / sulfate reduction*	-163.87	-685.6	4.75:1
$5.5H_2O + C_6H_4(CH_3)_2 \Rightarrow 2.75CO_{2,g} + 5.25CH_4$ *m-Xylene oxidation / methanogenesis*	-36.95	-154.6	0.79:1 [b/]

TABLE 6.3 (Concluded)
COUPLED OXIDATION REACTIONS
Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina

Coupled Naphthalene Oxidation Reactions	$\Delta G°_r$ (kcal/mole naphthalene)	$\Delta G°_r$ (kJ/mole naphthalene)	Stoichiometric Mass Ratio of Electron Acceptor to Compound
$12O_2 + C_{10}H_8 \Rightarrow 10CO_2 + 4H_2O$ *Naphthalene oxidation /aerobic respiration*	-1217.40	-5094	3.00:1
$9.6NO_3^- + 9.6H^+ + C_{10}H_8 \Rightarrow 10CO_2 + 8.8H_2O + 4.8N_2$ *Naphthalene oxidation / denitrification*	-1234.04	-5163	4.65:1
$24MnO_2 + 48H^+ + C_{10}H_8 \Rightarrow 10CO_2 + 24Mn^{2+} + 28H_2O$ *Naphthalene oxidation / manganese reduction*	-1217.57	-5094	16.31:1
$48Fe(OH)_{3,a} + 96H^+ + C_{10}H_8 \Rightarrow 10CO_2 + 48Fe^{2+} + 124H_2O$ *Naphthalene oxidation / iron reduction*	-932.64	-3902	40.13:1
$6SO_4^{2-} + 12H^+ + C_{10}H_8 \Rightarrow 10CO_2 + 6H_2S^o + 4H_2O$ *Error! Switch argument not specified.Naphthalene oxidation / sulfate reduction*	-196.98	-824.2	4.50:1
$8H_2O + C_{10}H_8 \Rightarrow 4CO_2 + 6CH_4$ *Naphthalene oxidation / methanogenesis*	-44.49	-186.1	0.75:1

[a/] Mass of ferrous iron produced during microbial respiration.
[b/] Mass of methane produced during microbial respiration.



Notes

ORP = Oxidation Reduction Potential

Range of ORP measured at Building 4522

1. These reactions would be expected to occur in sequence if the system is moving toward equilibrium.

2. These redox processes occur in order of their energy-yielding potential (provided microorganisms are available to mediate a specific reaction). Reduction of a highly oxidized species decreases the ORP of the system.

3. The ORP of the system determines which electron acceptors are available for organic carbon oxidation.

4. Redox sequence is paralleled by an ecological succession of biological mediators.

Adapted from Stumm and Morgan, 1981 and Norris *et al.*, 1994.

FIGURE 6.3

SEQUENCE OF MICROBIALLY MEDIATED REDOX PROCESSES

Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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anaerobic conditions dominate the interior regions of the contaminant plume, anaerobic microorganisms can utilize other electron acceptors in the following order of preference: nitrate/nitrite, manganese, ferric iron, sulfate, and finally carbon dioxide. Each successive redox reaction provides less energy to the system, and each step down in redox energy yield would have to be paralleled by an ecological succession of microorganisms capable of facilitating the pertinent redox reactions.

The expected sequence of redox processes can be estimated by the ORP of the groundwater. The ORP measures the relative tendency of a solution or chemical reaction to accept or transfer electrons, and can be measured in the field. This measurement can be used as a crude indicator of which redox reactions may be operating at a site. High ORPs mean that the solution (or available redox couple) has a relatively high oxidizing potential.

Microorganisms can facilitate the biodegradation (oxidation) of the fuel hydrocarbon compounds only by using redox couples that have a higher ORP than the contaminants. This is why these electron acceptors can be used to oxidize the fuel hydrocarbon compounds. The reduction of highly oxidized species results in an overall decrease in the oxidizing potential of the groundwater. As shown in Figure 6.3, the reduction of oxygen and nitrate will reduce the oxidizing potential to levels at which ferric iron (Fe^{3+}) reduction can occur. As each chemical species that can be used to oxidize the contaminants is exhausted, the microorganisms are forced to use other available electron acceptors with lower oxidizing capacity. When sufficiently low (negative) ORP levels have been developed as a result of these redox reactions, sulfate reduction and methanogenesis can occur almost simultaneously (Stumm and Morgan, 1981).

ORP values measured in shallow groundwater at the site in December 1998 ranged from –172.2 millivolts (mV) at MW3 to 227.7 mV at MW2 (Table 6.4). Areas with the lowest ORP measurements generally coincided with the presence of fuel-contaminated groundwater, indicating that the progressive use of electron acceptors in the order shown on Figure 6.3 has caused the groundwater in the contaminated areas to become more reducing. These data imply that oxygen, nitrate, manganese, and ferric iron may be used to biodegrade fuel hydrocarbon contaminants at this site. However, many authors have noted that field ORP data alone cannot be used to reliably predict all of the electron acceptors that may be operating at a site, because the platinum electrode probes are not sensitive to some redox couples (e.g., sulfate/sulfide) (Stumm and Morgan, 1981; Godsey, 1994; Lovley *et al.*, 1994). Analytical data on oxidized and reduced species are presented in the following subsections to verify which electron acceptors actually are being used to biodegrade the BTEX in saturated soil and groundwater at the site.

Throughout the following subsections, the distributions of geochemical parameters are examined by comparing background concentrations to BTEX plume core concentrations. Analytical data from upgradient (MW5) and cross-gradient (MW2) wells are used for background concentrations. Analytical data from wells MPB and MW4 are used for BTEX plume core concentrations.

TABLE 6.4
SUMMARY OF GROUNDWATER GEOCHEMICAL DATA
Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina

Parameter	Units	MPA 4-Dec-98	MPB 2-Dec-98	MW2 3-Dec-98	MW3 3-Dec-98	MW4 2-Dec-98	MW5 2-Dec-98	MW6 2-Dec-98	MW7 1-Dec-98	MW8 1-Dec-98
Ferrous Iron	mg/L [a/]	5.6	10.7	0.21	2.56	23.2	0.22	1.07	6.65	DRY[b/]
Sulfate	mg/L	---[c/]	10.3	25.4	---	36.1	24.6	19.0	---	DRY
Nitrate	mg/L	---	1.0UJ[d/]	1.0U	---	1.0U	0.41J1[e/]	---	---	---
Methane	µg/L	---	1200B,D[f/]	3.4	---	1700B,D[g/]	0.31U	---	---	---
Temperature	Deg C [g/]	24.7	19.3	16.9	18.1	19.8	23.1	18.2	19.7	19.8
pH	SU [h/]	mm(2.86)[i/]	4.97	4.6	5.8	6.25	4.88	5.04	mm(3.55)	mm(3.38)
Conductivity	µS/cm [j/]	170	107	125	127	44	113	114	121	130
Dissolved Oxygen	mg/L	2.0	0.58	1.12	1.16	0.45	0.89	3.15	3.46	3.03
ORP [k/]	mV [l/]	14.7	-163.2	227.7	-172.2	-68.9	207.1	137.2	39.5	122.7
Ammonia	mg/L	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.3	DRY

[a/] mg/L = milligrams per liter.

[b/] DRY = The well went dry prior to analyzing this parameter.

[c/] --- = Not analyzed.

[d/] U = The analyte was analyzed for and is not present above the reporting limit shown.

J = The analyte was positively identified, but the value may not be representative of what is actually present.

[e/] J1 = This is an estimated result. The analyte was positively identified and has a concentration between the method detection limit and the reporting limit.

[f/] B = Method blank contamination. The associated method blank contains the target analyte at a reportable level.

D = Result was obtained from the analysis of a dilution.

[g/] Deg C = degrees Celsius.

[h/] SU = Standard Units.

[i/] mm = Meter malfunction. The pH meter was not calibrating properly during these measurements.

[j] mS/cm = microsiemens per centimeter.

[k/] ORP = oxidation reduction potential.

[l/] mV = millivolts.

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6.4.2 Dissolved Oxygen

Almost all types of fuel hydrocarbons can be biodegraded under aerobic conditions (Borden *et al.*, 1994). Mineralization of fuel hydrocarbons to carbon dioxide and water under aerobic conditions involves the use of oxygen as a cosubstrate during the initial stages of metabolism, and as a terminal electron acceptor during the later stages of metabolism for energy production. The reduction of molecular oxygen during the oxidation of the fuel hydrocarbon compounds yields a significant amount of free energy that the microorganisms could utilize.

DO concentrations were measured at groundwater sampling locations in December 1998. Table 6.4 presents the analytical results for DO by sampling location. DO measured in groundwater from background wells ranged from 0.89 mg/L to 1.12 mg/L and averaged 1.0 mg/L. DO measured in contaminated groundwater in the plume core ranged from 0.45 mg/L to 0.58 mg/L and averaged 0.52 mg/L. The presence of the lowest observed DO concentration (0.45 mg/L) in the most contaminated sample, MW4, is an indication that biodegradation through aerobic respiration has occurred in this area.

6.4.3 Nitrate

Once available DO concentrations are depleted through aerobic respiration, nitrate can be used as an electron acceptor by indigenous facultative anaerobes that mineralize fuel hydrocarbon compounds via either denitrification or nitrate reduction processes. Concentrations of nitrate (as nitrogen [N]) measured at the site in December 1998 are summarized in Table 6.4. Nitrate measured in groundwater from background wells ranged from 0.41 mg/L to less than (<) 1.0 mg/L and averaged 0.21 mg/L. The average was computed by assuming that the nitrate concentration at MW2 was one-half the method detection limit of 0.02 mg/L. Nitrate was not detected in the plume core samples. These data suggest that nitrate concentrations within the dissolved plume are depleted relative to measured background concentrations. The results indicate that minor amounts of nitrate are being used to oxidize fuel hydrocarbons in the anaerobic core of the dissolved plumes via the anaerobic process of denitrification.

6.4.4 Ferrous Iron

Although relatively little is known about the anaerobic metabolic pathways involving the reduction of ferric iron (Fe^{3+}), this process has been shown to be a major metabolic pathway for some microorganisms (Lovley and Phillips, 1988; Chapelle, 1993). Elevated concentrations of ferrous iron (Fe^{2+}) often are found in anaerobic, fuel-contaminated groundwater systems. Concentrations of dissolved ferrous iron once were attributed to the spontaneous and reversible reduction of ferric oxyhydroxides, which are thermodynamically unstable in the presence of organic compounds such as benzene. However, more recent studies suggest that the reduction of ferric iron cannot proceed at all without microbial mediation (Lovley and Phillips, 1988; Lovley *et al.*, 1991; Chapelle, 1993). None of the common organic compounds found in low-temperature, neutral, reducing groundwater could reduce ferric oxyhydroxides to ferrous iron under sterile laboratory conditions (Lovley *et al.*, 1991). This means that the reduction of ferric iron to ferrous iron requires mediation by microorganisms with the appropriate enzymatic capabilities.

To determine if ferric iron is being used as an electron acceptor for fuel biodegradation at the site, ferrous (reduced) iron concentrations were measured at groundwater sampling locations in December 1998. The data are summarized in Table 6.4. Ferrous iron concentrations measured in groundwater from background wells ranged from 0.21 mg/L to 0.22 mg/L. Ferrous iron measured in contaminated groundwater ranged from 10.7 mg/L to 23.2 mg/L and averaged 17.0 mg/L. The occurrence of elevated ferrous iron concentrations within the plume core strongly indicates that ferric iron is acting as an electron acceptor at this location and that fuel hydrocarbons are being biodegraded via the microbially-mediated process of ferric iron reduction.

6.4.5 Sulfate

Sulfate also may be used as an electron acceptor during microbial degradation of fuel hydrocarbons under anaerobic conditions (Grbic'-Galic', 1990). Sulfate can be reduced to sulfide during the oxidation of the fuel hydrocarbon compounds. The presence of decreased concentrations of sulfate in the source area relative to background concentrations indicates that sulfate is participating in redox reactions at the site. To investigate the potential for sulfate reduction at the site, sulfate concentrations were measured during the December 1998 groundwater sampling event. The data are summarized in Table 6.4. Sulfate measured in groundwater from background wells ranged from 24.6 mg/L to 25.4 mg/L and averaged 25 mg/L. Sulfate measured in contaminated groundwater ranged from 10.3 mg/L to 36.1 mg/L and averaged 23.2 mg/L. The similarity between average background and plume core sulfate concentrations suggests that sulfate reduction is not a significant biodegradation process throughout the plume. Rather, this process may be only locally significant (e.g., at MPB).

6.4.6 Dissolved Methane

On the basis of free energy yield and the oxidizing potential of the site groundwater, the carbon dioxide/methane (CO_2/CH_4) redox couple also could be used to oxidize fuel hydrocarbon compounds to CO_2 and water once the groundwater is sufficiently reducing. To attain these reducing levels, other highly oxidized chemical species such as oxygen, nitrate, ferric iron, and sulfate must first be reduced. This redox reaction is called methanogenesis or methane fermentation. Methanogenesis yields the least free energy to the system in comparison to other chemical species (Table 6.4). The presence of methane in groundwater at elevated concentrations relative to background concentrations is a good indicator of methane fermentation.

Dissolved methane was measured at groundwater monitoring wells sampled during the December 1998 sampling event. Table 6.4 presents the analytical data for methane. Methane concentrations measured in groundwater from background wells ranged from 0.31 µg/L to 3.4 µg/L and averaged 1.9 µg/L. In contrast, methane concentrations measured in contaminated groundwater ranged from 1,200 µg/L to 1,700 µg/L and averaged 1,450 µg/L. The presence of elevated methane levels in groundwater at the site strongly indicates that biodegradation is occurring via methanogenesis.

6.4.7 pH

The pH of groundwater samples collected from groundwater monitoring points and monitoring wells in December 1998 was measured (Table 6.4). The pH of a solution is the negative logarithm of the hydrogen ion concentration [H^+]. Groundwater pH values measured at the site were slightly below the optimal range for fuel hydrocarbon-degrading microbes of 6 to 8 standard units (SUs); however, calibration of the pH meter was difficult to maintain due to a malfunctioning meter or probe. The majority of groundwater samples collected at the former AGE Fueling Facility ranged between 5 and 7 SUs (Parsons ES, 1996).

6.4.8 Temperature

Groundwater temperature was measured at groundwater monitoring wells in December 1998 (Table 6.4). Temperature affects the types and growth rates of bacteria that can be supported in the groundwater environment, with higher temperatures generally resulting in higher growth rates. The temperature of groundwater samples collected from the shallow monitoring wells varied from 16.9 degrees Celsius (°C) to 24.7 °C. The relatively warm temperatures should promote microbial growth and may enhance rates of hydrocarbon biodegradation.

6.5 THEORETICAL ASSIMILATIVE CAPACITY ESTIMATES

The preceding discussions have been devoted to determining if fuel hydrocarbons are biodegrading in saturated soil and groundwater at the site. Analytical data on reduced and oxidized chemical species indicate that indigenous microorganisms are facilitating the oxidation of fuel hydrocarbons and the reduction of electron acceptors to generate free energy for cell maintenance and production. The question of how much contaminant mass can be biodegraded must be addressed to assess the full potential for long-term intrinsic bioremediation to minimize plume size and mass over time.

Mass balance relationships can be used to determine how much contaminant mass can be degraded by each of the redox reactions that the microorganisms might use to make free energy available for cell maintenance and production. The stoichiometric relationship between the contaminant and the electron acceptor can be used to estimate the expressed assimilative capacity of the groundwater. Once the redox reactions operating at the site have been defined, it is possible to estimate how much contaminant mass can be assimilated or oxidized by available electron acceptors.

Table 6.3 presents the coupled redox reactions that represent the biodegradation of the individual COPCs, including the stoichiometric mass ratio of electron acceptors needed to oxidize each compound. These stoichiometric mass ratios can be used to estimate the assimilative capacity of the groundwater at Building 4522. For oxygen, nitrate, and sulfate, this is accomplished by first determining the initial (background) mass of each electron acceptor available in the groundwater. Data on these chemical species were collected at sampling locations upgradient and cross-gradient from the dissolved plume. As groundwater slowly migrates into the source area, electron acceptors are brought into contact with hydrocarbon-degrading microorganisms and site contamination. The change in the electron acceptor mass from background sampling locations to sampling locations

within the plume core is divided by the mass of electron acceptors required to mineralize the COPCs. For ferrous iron and methane, the highest observed concentration in the plume core wells is divided by the mass of electron acceptors required to mineralize the COPC. These numbers are summed to estimate the expressed intrinsic capacity of the groundwater to biodegrade each COPC.

Estimates of the background and plume core concentrations were used to calculate the expressed assimilative capacity of the groundwater system attributable to aerobic respiration, denitrification, and sulfate reduction. The source area concentrations of ferrous iron and methane are used to "back-calculate" the expressed assimilative capacity that is attributable to ferric iron reduction and methanogenesis. The calculations are summarized in Table 6.5. This estimate essentially represents an estimate of the reduction capability of one pore volume of groundwater at Building 4522. The estimate identifies how much contaminant mass can be theoretically oxidized as one pore volume travels through the plume core. In reality, multiple pore volumes are expected to move through the contaminated aquifer material in the source area each year based on the estimated average groundwater velocity of 86 ft/yr.

On the basis of these calculations, one pore volume of saturated soil and groundwater at Building 4522 has the capacity to oxidize an average total BTEX plus naphthalene concentration of approximately 3,200 μg/L. The maximum total BTEX plus naphthalene concentration detected in site groundwater in December 1998 was 6,660 μg/L at MW4. Although a single pore volume of water does not contain enough electron acceptors to completely degrade the dissolved hydrocarbons at this site, the influx of multiple pore volumes through the site will eventually degrade the remaining BTEX.

A closed system containing 2 liters of water can be used to help visualize the physical meaning of assimilative capacity. Assume that the first liter contains no fuel hydrocarbons, but it contains fuel-degrading microorganisms and has an assimilative capacity of exactly "x" mg of fuel hydrocarbons. The second liter has no assimilative capacity; however, it contains fuel hydrocarbons. As long as these 2 liters of water are kept separate, biodegradation of fuel hydrocarbons will not occur. If these 2 liters are combined in a closed system, biodegradation will commence and continue until the fuel hydrocarbons or electron acceptors are depleted. If less than "x" mg of fuel hydrocarbons are in the second liter, all of the fuel hydrocarbons will eventually degrade given a sufficient time; likewise, if greater than "x" mg of fuel hydrocarbons were in the second liter of water, only "x" mg of fuel hydrocarbons would ultimately degrade.

This example shows that in a closed system, the measured expressed assimilative capacity eventually should be equivalent to the loss in contaminant mass; however, the groundwater beneath the site is an open system. Electron acceptors can continually enter the system from upgradient flow. Furthermore, contaminant mass can be added to the system through dissolution or leaching from LNAPL or contaminated soil. This means that the assimilative capacity is not fixed as it would be in a closed system, and therefore should not be quantitatively compared to concentrations of dissolved contaminants in the groundwater. Rather, the expressed assimilative capacity of groundwater is intended to serve as a qualitative tool. The fate of BTEX in groundwater is dependent on the relationship between the kinetics of biodegradation and the solute transport velocities (Chapelle, 1994).

TABLE 6.5
ESTIMATED ASSIMILATIVE CAPACITY OF SATURATED SOIL AND GROUNDWATER
Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina

BENZENE

Electron Acceptor or Metabolic Byproduct	Background [a/] Concentration (mg/L) [c/]	Concentration in [b/] Core of Plume (mg/L)	Mass Ratio of Electron Acceptor/ Byproduct to COPCs [d/] (unitless)	Benzene Assimilative Capacity [e/] (mg/L)
Oxygen	1.01	0.515	3.07	0.16
Nitrate	0.21	0.0	4.77	0.04
Sulfate	25.0	23.2	4.61	0.39
Ferrous Iron	0.22	16.95	21.5	0.79
Methane	0.0019	1.45	0.77	1.88
			Total	3.27
			Max. 1998 Concentration (mg/L)	1.3

TOLUENE

Electron Acceptor or Metabolic Byproduct	Background [a/] Concentration (mg/L) [c/]	Concentration in [b/] Core of Plume (mg/L)	Mass Ratio of Electron Acceptor/ Byproduct to COPCs [d/] (unitless)	Toluene Assimilative Capacity [e/] (mg/L)
Oxygen	1.01	0.515	3.13	0.16
Nitrate	0.21	0.0	4.85	0.04
Sulfate	25.0	23.2	4.7	0.38
Ferrous Iron	0.22	16.95	21.86	0.78
Methane	0.0019	1.45	0.78	1.86
			Total	3.22
			Max. 1998 Concentration (mg/L)	2.9

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TABLE 6.5 (continued)
ESTIMATED ASSIMILATIVE CAPACITY OF SATURATED SOIL AND GROUNDWATER
Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina

ETHYLBENZENE

Electron Acceptor or Metabolic Byproduct	Background [a/] Concentration (mg/L) [c/]	Concentration in [b/] Core of Plume (mg/L)	Mass Ratio of Electron Acceptor/ Byproduct to COPCs [d/] (unitless)	Ethylbenzene Assimilative Capacity [e/] (mg/L)
Oxygen	1.01	0.515	3.17	0.16
Nitrate	0.21	0.0	4.92	0.04
Sulfate	25.0	23.2	4.75	.0.38
Ferrous Iron	0.22	16.95	22	0.77
Methane	0.0019	1.45	0.79	1.84
			Total	3.18
			Max. 1998 Concentration (mg/L)	0.65

XYLENES

Electron Acceptor or Metabolic Byproduct	Background [a/] Concentration (mg/L) [c/]	Concentration in [b/] Core of Plume (mg/L)	Mass Ratio of Electron Acceptor/ Byproduct to COPCs [d/] (unitless)	Xylenes Assimilative Capacity [e/] (mg/L)
Oxygen	1.01	0.515	3.17	0.16
Nitrate	0.21	0.0	4.92	0.04
Sulfate	25.0	23.2	4.75	0.38
Ferrous Iron	0.22	16.95	22	0.77
Methane	0.0019	1.45	0.79	1.84
			Total	3.18
			Max. 1998 Concentration (mg/L)	2.3

TABLE 6.5 (concluded)
ESTIMATED ASSIMILATIVE CAPACITY OF SATURATED SOIL AND GROUNDWATER
Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina

NAPHTHALENE

Electron Acceptor or Metabolic Byproduct	Background [a] Concentration (mg/L) [c]	Concentration in [b] Core of Plume (mg/L)	Mass Ratio of Electron Acceptor/ Byproduct to COPCs [d] (unitless)	Naphthalene Assimilative Capacity [e] (mg/L)
Oxygen	1.01	0.515	3.00	0.17
Nitrate	0.21	0.0	4.65	0.05
Sulfate	25.0	23.2	4.50	0.40
Ferrous Iron	0.22	16.95	40.13	0.42
Methane	0.0019	1.45	0.75	1.93
			Total	2.97
			Max. 1998 Concentration (mg/L)	0.21

a/ Background concentrations were average from two background wells (MW2 and MW5).

b/ Concentrations in core of plume were averaged from the two plume wells (MPB and MW4).

c/ mg/L = milligrams per liter.

d/ Calculation based on the ratio of the total mass of electron acceptor required to oxidize a given average of the mass of contaminants of potential concern (BTEX and naphthalene).

e/ Assimilative capacity is the amount of contaminant that can be degraded by a given process.

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6.6 PREDICTING CONTAMINANT TRANSPORT AND FATE

Understanding the effects of natural physical, chemical, and biological processes on chemicals in the subsurface is an important step in determining potential long-term risks associated with chemical migration in the environment. The behavior of COPCs under the influence of these processes must be quantified to assess the expected persistence, mass, concentration, and toxicity of dissolved COPCs over time at the site and to estimate potential receptor exposure-point concentrations. If destructive and nondestructive attenuation processes can minimize or eliminate the concentration of contaminants to which a receptor could be exposed, engineered remedial action may not be warranted either because no reasonable exposure pathway exists or because the exposure pathway would result in insignificant risks. The focus of this section is to predict how the COPCs will be naturally attenuated over time in soil and groundwater based on site data and site-specific contaminant transport and fate models.

BIOSCREEN is a screening model which simulates RNA of dissolved hydrocarbons at petroleum fuel release sites (Newell *et al.*, 1996). The software is based on the Domenico (1987) analytical solute transport model and is designed to simulate advection, dispersion, adsorption, and aerobic decay as well as anaerobic reactions that have been shown to be the dominant biodegradation processes at many petroleum release sites. BIOSCREEN modeling using Version 1.4 was performed for Building 4522 primarily to estimate the maximum migration distance of the dissolved benzene plume over time. Benzene was selected for simulation because it is relatively mobile and toxic compared to the other BTEX compounds, and therefore will be a primary "risk-driver" chemical at the site.

6.6.1 Description of BIOSCREEN Model

BIOSCREEN includes three different model types:

1. Solute transport without decay;
2. Solute transport with biodegradation modeled as a first-order decay process (simple, lumped parameter approach); and
3. Solute transport with biodegradation modeled as an "instantaneous" biodegradation reaction.

The first model is appropriate for predicting the movement of conservative (non-degrading) solutes such as chloride. The only attenuation mechanisms simulated are dispersion in the longitudinal, transverse, and vertical directions and adsorption of the chemical to the soil matrix. At almost all petroleum release sites, biodegradation is present and can be verified by demonstrating the consumption of aerobic and anaerobic electron acceptors. Therefore, results from the No Biodegradation model are intended only to be used for comparison purposes and to demonstrate the effects of biodegradation on plume migration.

With the first-order model, the solute degradation rate is proportional to the initial solute concentration. This is a conventional method for simulating biodegradation in

dissolved hydrocarbon plumes. With this method, dispersion, sorption, and biodegradation parameters are lumped together in a single calibration parameter (a first-order decay rate). The first-order model does not assume any biodegradation of dissolved constituents in the source zone, and therefore may underpredict the rate of decrease of source area contaminant concentrations. In other words, this model assumes that biodegradation starts immediately downgradient from the source and that it does not decrease the concentrations of dissolved organic compounds in the source zone itself.

With the instantaneous reaction model, contaminant mass concentrations at any location and time within the flow field are corrected by subtracting 1 mg/L organic mass for each mg/L of biodegradation capacity provided by all of the available electron acceptors, in accordance with the instantaneous reaction assumption. In other words, this model uses the assimilative capacity of the groundwater system to biodegrade contaminant mass.

6.6.2 Conceptual Model Design and Limiting Assumptions

BIOSCREEN has the following limitations:

- As an analytical model, BIOSCREEN assumes simple groundwater flow conditions; and
- As a screening tool, BIOSCREEN only approximates the more complicated processes that occur in the field.

Because the model is not capable of simulating a complicated flow regime, the hydraulic input parameters for the site were based on the average values calculated or estimated using site-specific data and widely-accepted literature values.

6.6.3 Model Input Data

Input data for the BIOSCREEN model are used to specify or calculate groundwater velocity, aquifer dispersivity, a retardation factor, a chemical-specific decay coefficient, dissolved hydrocarbon concentrations in the source area, a half-life of the hydrocarbon source, and the dimensions of the source zone. The parameters were obtained from site-specific data and commonly accepted literature values. The BIOSCREEN input screen is presented in Appendix F. Each of these input values is described in more detail below.

6.6.3.1 Hydrogeology

Seepage Velocity (V_s) Seepage velocity is the actual interstitial groundwater velocity. It is defined as the hydraulic conductivity multiplied by the hydraulic gradient divided by the effective porosity. The V_s value used in the model is 86 ft/year (0.24 ft/day).

Hydraulic Conductivity (K) Hydraulic conductivity (K) is a term that describes the relative ease with which water can move through a permeable medium. The horizontal K value used for shallow aquifer modeling, 11.8 ft/day, was derived as described in Section 3.2.

Hydraulic Gradient (dH/dL) The hydraulic gradient is a unitless value which represents the change in water table elevation per unit distance in a direction parallel to groundwater flow. The average hydraulic gradient at the site along the plume flowpath was calculated to be 0.003 ft/ft based on water table elevation data collected in December 1998.

Effective Porosity (n_e) The effective porosity of a medium is the ratio of the volume of interconnected voids to the bulk volume of the aquifer matrix. The effective porosity is typically less than total porosity because of non-interconnected pores, dead-end pores, and boundary effects of aquifer solids. An effective porosity of 0.15 (15 percent) was used for the model. This value is judged to be representative of the shallow silty sand aquifer based on values reported in the literature (e.g., Spitz and Moreno, 1996).

6.6.3.2 Dispersion

Dispersivity is a property of a porous medium that determines the dispersion or spreading characteristics of the medium by a relationship between pore-water velocity and dispersion coefficients. Published data summarized by Spitz and Moreno (1996) suggest that, as a rule of thumb, longitudinal dispersivity is approximately one-tenth the travel distance of the plume (from the source to the downgradient toe). A longitudinal dispersivity of 45 feet was input into the model based on an estimated plume length of 450 feet. The transverse dispersivity value is estimated as one-tenth of the longitudinal dispersivity value (Domenico and Schwartz, 1990), and vertical dispersivity is assumed to be negligible.

6.6.3.3 Adsorption

Retardation Factor The retardation factor is a measure of the degree of retardation of dissolved organic chemical movement through the aquifer. An averge retardation value of 1.5 was calculated for benzene (Table 6.6); this value was used in the BIOSCREEN model.

Organic Carbon Partition Coefficient (K_{oc}) The organic carbon partition coefficient (K_{oc}) is a chemical-specific partition coefficient between organic carbon and water (Newell *et al.*, 1996). The selected K_{oc} value for benzene was 79 liters per kilogram (L/kg) (Weidemeier *et al.*, 1995).

Fraction Organic Carbon (f_{oc}) The fraction organic carbon (f_{oc}) is the weight fraction of organic carbon in soil and is used in the estimation of the retardation factor. Typical f_{oc} values range from 0.0002 to 0.02 (Knox *et al.*, 1993). Measured total organic carbon levels were 590 mg/kg and 1,980 mg/kg, and an average value of 1,285 mg/kg was assumed to exist in site soil, which translates to a f_{oc} value of 1.285×10^{-3}.

Soil Bulk Density (ρ_b) The soil bulk density is the bulk density of the aquifer matrix and is related to the porosity and pure solids density. An estimated value of 1.8 kilograms per liter (kg/L) was used in this model (Newell *et al.*, 1996).

TABLE 6.6
RETARDATION COEFFICIENTS FOR COPCs
Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina

Compound	K_{oc} (L/kg [a/])	Minimum foc[b/]	Average foc	Maximum foc	Minimum K_d[c/] (L/kg)	Average K_d (L/kg)	Maximum K_d (L/kg)	Bulk Density (kg/L)[d/]	Total Porosity	Minimum Coefficient of Retardation	Average Coefficient of Retardation	Maximum Coefficient of Retardation
Benzene	79	0.00059	0.001285	0.00198	0.047	0.102	0.156	1.80	0.35	1.24	1.52	1.80
Toluene	190	0.00059	0.001285	0.00198	0.112	0.244	0.376	1.80	0.35	1.58	2.26	2.93
Ethylbenzene	468	0.00059	0.001285	0.00198	0.276	0.601	0.927	1.80	0.35	2.42	4.09	5.77
Xylenes	395	0.00059	0.001285	0.00198	0.233	0.508	0.782	1.80	0.35	2.20	3.61	5.02
Naphthalene	550	0.00059	0.001285	0.00198	0.325	0.707	1.089	1.80	0.35	2.67	4.63	6.60

[a/] L/kg = liters per kilogram.
[b/] foc = fraction organic carbon.
[c/] k_d = distribution coefficient.
[b/] kg/L = kilograms per liter.

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6.6.3.4 Biodegradation

First Order Decay Coefficient and Solute Half-Life The solute half-life is a chemical specific value which specifies the amount of time it takes for a compound to degrade to half its original concentration. The first-order decay coefficient is equal to the natural log of 2 (0.693) divided by the half-life of the chemical in groundwater. The half-life for benzene in groundwater typically ranges from 0.027 year to 2 years (Newell *et al.*, 1996 and Howard *et al.*, 1991). Instead of using a literature value, a first-order decay coefficient in the range of values calculated for benzene and BTEX at the Building 4522 site and the former AGE Fueling Facility (0.0035 day^{-1}, see Section 6.3.2) was used in the model. As described in Section 6.3.2, this value is very similar to the benzene decay coefficient computed for the Building 4522 site (0.0049 day^{-1}) and the former AGE Fueling Facility (0.0036 day^{-1}). The value of 0.0036 day^{-1} was computed using a conservative tracer method that does not require the presence of steady-state plume conditions. Therefore, this value may be the best estimate of the actual benzene decay rate at these sites.

Instantaneous Reaction Model As described in Section 6.7.4, the Instantaneous Reaction Model was not used for prediction purposes because a reasonable calibration to total BTEX concentrations measured in site groundwater samples could not be achieved. Geochemical input data used in this model are described in Appendix F.

6.6.3.5 General

The modeled area length and width were set at 750 feet and 500 feet, respectively. The model was run for 3 years for calibration purposes (1995 to 1998) and for an additional 30 years (1998 to 2028) for predictive purposes.

6.6.3.6 Source Data

Source Thickness in Saturated Zone The source thickness in the aquifer was input as 2 feet, based on an estimate of the thickness of the residual product smear zone below the water table.

Source Area Dimensions and Concentrations BIOSCREEN assumes a source represented by a vertical plane perpendicular to groundwater flow. This vertical plane was estimated using the dissolved benzene plume dimensions and concentrations in December 1998.

Source Half-Life BIOSCREEN incorporates an approximation for a declining source concentration over time. The declining source term assumes that the mass of modeled constituent in the source area dissolves slowly as fresh groundwater passes through, and that the change in source zone concentration can be approximated as a first-order decay process. The model will compute an estimated source half-life given the estimated mass of modeled constituent present in the source area. The initial mass of benzene available to be dissolved into groundwater at the site was estimated to be 8.4 kg based on soil contamination data collected in March 1998 during the fuel weathering study (Parsons ES, 1999) (Appendix E). The calculated mass assumes that all recoverable free product will be extracted from the subsurface, and that the March 1998 soil quality data are

representative of remaining residual product concentrations. Calculations are contained in Appendix E.

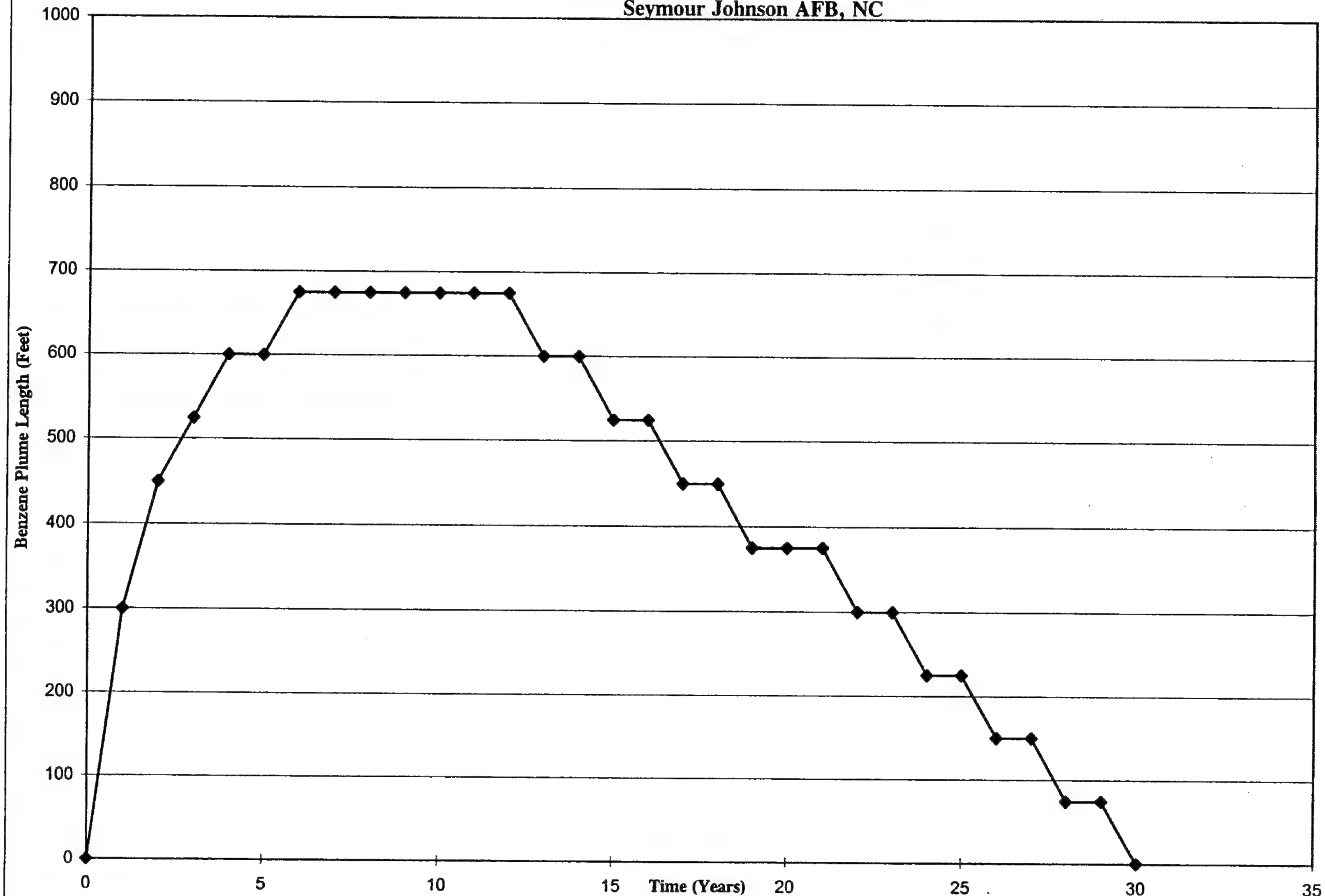
6.6.4 Model Calibration and Results

Attempts were made to calibrate the model to dissolved benzene and total BTEX concentrations measured in wells MW4 and MW7 in December 1998 using both the first-order and instantaneous reaction models. A reasonable calibration to the total BTEX concentrations could not be achieved using the instantaneous reaction model. In contrast, the first-order decay model was readily calibrated to measured benzene and BTEX concentrations. For this reason, and because the first-order decay coefficient calculated for the site was very similar to the coefficient previously calculated for the former AGE Fueling Facility (Parsons ES, 1996), only the first-order model was used for predictive purposes. During the calibration process, the longitudinal dispersivity was decreased from 45 feet to 43 feet, and the simulated maximum dissolved benzene concentration in the source area (immediately following the spill in 1995) was increased to 14 mg/L. This represents the maximum concentration of benzene in source area groundwater immediately following the spill in 1995 necessary to generate the observed downgradient concentrations.

The maximum predicted migration distance of the dissolved benzene plume is shown on Figure 6.4. The First-Order Decay model indicates that the dissolved benzene plume will migrate to its maximum distance of approximately 680 feet from the source area (approximately 230 feet downgradient from well MW7) after approximately 6 years (year 2004), after which it will achieve a steady state condition that lasts for 6 years (year 2010). After 2010, the model predicts that the benzene plume will recede toward the source area. Model input and output is presented in Appendix F. The storm sewer discharges into the open ditch approximately 950 feet northwest of the source area; therefore, the benzene plume is not predicted to reach the ditch, which represents the closest potential receptor exposure point. Because benzene is relatively mobile, it can be concluded that other less-mobile fuel constituents also will not migrate to the ditch.

The conclusion that dissolved fuel constituents will not migrate to the ditch is supported by data presented by Lawrence Livermore National Laboratories (LLNL). These data indicate that for over 1,000 California sites with fuel hydrocarbon releases, 33 percent of the plumes were shrinking, 59 percent were stable, and 8 percent were expanding, with most plumes less than 250 feet long (Rice *et al.*, 1995). Unpublished data provided by Kuehne and Buscheck (1996) indicate similar trends, with 52 percent of plumes contracting, 35 percent stable, and 92 percent of the plumes being less than 200 feet long. Mace *et al.* (1997) present similar evidence for more than 600 sites in Texas.

FIGURE 6.4
BENZENE PLUME LENGTH VS. TIME
Risk-Based Approach to Remediation
Seymour Johnson AFB, NC



022/731854/SJ/Seymour 98 Chart 2

SECTION 7

TIER 2 ANALYSIS AND IDENTIFICATION OF FINAL CHEMICALS OF CONCERN

7.1 OBJECTIVE OF SITE-SPECIFIC EVALUATION

The Tier 1 analysis conducted in this CAP (Section 4) identified benzene, toluene, and xylenes as COPCs in soil gas at the Building 4522 site. In this section, COPCs in soil gas are evaluated in detail to better define/assess the potential adverse health effects they may cause in current or future human receptors. Maximum detected contaminant concentrations in soil and surface water did not exceed their respective Tier 1 screening levels; therefore, further analysis of these matrices is not necessary. All compound-specific contaminant concentrations detected in groundwater are less than the Tier 1 GCLs for this matrix; only VPH and EPH carbon fractions exceeded their Tier 1 screening levels [interim groundwater standards reported in NCDEHNR (1998a)]. The interim groundwater standards assume unrestricted groundwater use (e.g., use as a potable drinking water supply), and are therefore not applicable for this industrial site. Therefore, the groundwater matrix also will not be assessed further in this section. The Tier 2 analysis developed in this section focuses on soil gas.

The Tier 1 screening process is considered protective of human health because the Tier 1 risk-based screening criteria are based on conservative exposure assumptions. However, analytes identified as COPCs in Section 4 of this CAP (i.e., analytes with representative site concentrations exceeding Tier 1 TCLs) should not automatically be considered to be present at the site at levels that pose unacceptable threats to human health given the current and future exposure potential at this site. Rather, the exceedences of the conservative screening criteria indicate that further evaluation using more site-specific exposure scenarios is warranted. The presence of various analytes at concentrations above the applicable generic Tier 1 screening levels also justifies the need for a Tier 2 evaluation to assist in the development of corrective actions that can achieve the desired level of risk reduction at the site.

Tier 2 of the risk-based analysis is completed in Section 7.2 by comparing appropriate site soil gas concentrations (December 1998) to reasonable matrix-specific site-specific target levels (SSTLs) at receptor exposure points. These SSTLs are described as the Tier 2 risk-based screening criteria and differ from the generic Tier 1 screening levels in that the conservative exposure assumptions used to derive the generic Tier 1 levels (e.g., that the receptor directly inhales undiluted soil gas) are replaced with more realistic site-specific exposure assumptions (e.g., that soil gas migrates into buildings or ambient air where it is diluted prior to inhalation).

Development of site-specific exposure scenarios requires a reevaluation of the preliminary CSM presented in Section 4. The revised CSM for the site, which is presented in Section 7.3, identifies those receptors and exposure pathways that may be completed under current or hypothetical future exposure scenarios considering land uses and the results of the chemical fate and transport assessment presented in Section 6.

In summary, the objectives of developing SSTLs that include exposure assumptions more representative of actual site conditions are 1) to determine whether current or predicted future site concentrations of COPCs present an unacceptable risk to current and future receptors; and 2) to provide the necessary information to assess the cost and time required to lower site concentrations to achieve adequate risk reduction at the site.

7.2 DEVELOPMENT OF SITE-SPECIFIC TARGET LEVELS

The COPCs in soil gas at the Building 4522 site identified in Table 4.3, were screened against soil vapor SSTLs developed for inhalation of indoor air vapors (Table 7.1). The methodology used to calculate these SSTLs is based on the guidelines set forth in ASTM (1995). These Tier 2 SSTLs were developed incorporating risk and exposure assessment practices as recommended by the USEPA (CDLE, 1999). An EPA recommended target risk limit of 1×10^{-6} was used in developing the Tier 2 SSTLs. Currently, there are no regularly inhabited buildings present in the contaminated area. The only building present at the site is cross-gradient to the BTEX plume, and overlies the edge of the plume (Building 4522F). However, this scenario was evaluated in the event that such buildings are constructed in the future.

The SSTLs in soil vapor were calculated by estimating an attenuation factor that accounts for diffusion in the unsaturated zone and building foundation and dilution and mixing with the air in the building. After an acceptable risk-based indoor air concentration is established, the attenuation factor is applied to calculate the soil vapor concentration. The attenuation factor was derived using the Johnson & Ettinger (1991) model. This model considers advection as well as diffusion processes. When the basement of a building is under-pressurized relative to the surrounding soil vapor, pressure-driven vapor flow rises. In this condition, surrounding soil vapor can be drawn into the basement by advection. Natural climatic pressure fluctuations or running a heater in the building can cause this to occur (CDLE, 1999).

As shown in Table 7.1, benzene concentrations in the soil gas at Building 4522 exceed the indoor air SSTL. It should be noted that this comparison is conservative in that available data indicate that contaminant concentrations in the subsurface are decreasing due to weathering processes (Section 6.3). Therefore, if a building is constructed in the source area in the future, soil gas concentrations are likely to be lower than the concentrations measured in December 1998. If a building is constructed over the contaminated area in the future, then soil gas BTEX concentrations should be reassessed to determine if a significant inhalation risk to building occupants exists. Alternately, benzene concentrations in the indoor air could be measured directly.

Potential inhalation risks to intrusive and nonintrusive site workers breathing ambient (outdoor) air also were evaluated by comparing maximum detected benzene concentrations in site soil and groundwater samples to matrix-specific SSTLs that

TABLE 7.1
COMPARISON OF COPCs IN SOIL GAS TO SITE-SPECIFIC TARGET LEVELS (SSTLs)
Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina

Chemical of Potential Concern	Units	Maximum Detected Concentration	Tier 2 Health-Based SSTL RME[a/]	Maximum Detection Exceeds SSTL?
Benzene	µg/L	860	35	Yes
Toluene	µg/L	220	VP[b/]	No
Xylenes	µg/L	480	VP	No

[a/] State of Colorado Dept. of Labor and Employment, Oil Inspection Section "Storage Tank Regulations", February 1, 1999.

[b/] VP = denotes that even at a concentration equal to the vapor pressure of the chemical, a hazard quotient of 1 is not exceeded.

incorporate the inhalation pathway. This comparison is summarized in Table 7.2. The reasonable maximum exposure (RME) SSTLs are designed to illustrate the residual concentration that can persist in onsite soil or groundwater given "high-end" (reasonable maximum) exposure potential.

TABLE 7.2
COMPARISON OF MAXIMUM BENZENE CONCENTRATIONS TO SOIL AND GROUNDWATER SSTLS
RISK-BASED APPROACH TO REMEDIATION
SEYMOUR JOHNSON AFB, NORTH CAROLINA

Maximum Soil Benzene Concentration (mg/L)[a/]	RME Inhalation SSTL for Soil (mg/L)	Maximum Groundwater Benzene Concentration (μg/L)[b/]	RME SSTL for Groundwater (μg/L)
<2.3J[c/]	399	1,300	33,100

a/ mg/L = milligrams per liter.
b/ μg/L = micrograms per liter
c/ J = The analyte was positively identified, but the value may not be representative of what is actually present

The construction worker exposure assumptions used to derive the SSTLs were based on actual studies of construction-related exposures at Eglin AFB, Florida, and have been reviewed and accepted by the State of Florida. The exposure pathways included in the soil SSTLs include inhalation of volatilized contaminants in aboveground ambient air. The exposure pathways included in the groundwater SSTLs include inhalation of volatilized contaminants in aboveground ambient air (75 percent of the exposure frequency) and in an excavated trench (25 percent of the exposure frequency). SSTL calculations are contained in Appendix E. The fact that maximum detected benzene concentrations in soil and groundwater samples do not exceed these SSTLs indicates that contaminants volatilizing from these matrices do not pose an inhalation risk to intrusive or nonintrusive (outdoor) site workers.

7.3 REVISED CONCEPTUAL SITE MODEL

The preliminary CSM presented in Section 4 was used to qualitatively identify potential human and ecological receptors that may be exposed to site-related contaminants and to define the types of potential exposures at or in the vicinity of the Building 4522 site (Figure 4.1). The preliminary CSM described sources of contamination, release mechanisms, the affected physical media, potentially exposed populations or receptors, and how each receptor group could come into contact with site-related contamination. This preliminary CSM was used to identify which of the exposure assumptions used to develop generic cleanup criteria most closely approximates site conditions. The exposure assumptions incorporated into the generic Tier 1 screening levels were identified as generally representative of the types of exposure that could occur at the site, but perhaps overestimated the magnitude of exposure specific to current and expected future site conditions. The preliminary CSM exposure pathways are reevaluated

in this section using the Tier 2 chemical fate information presented in Sections 6 and 7.2. It is important to emphasize that the purpose of using the preliminary CSM and the conservative, nonsite-specific Tier 1 screening levels to identify COPCs was to ensure that all subsequent assessment activities beyond the Tier 1 screening evaluation address the full range of contaminants that may present some risk to current or future receptors.

The revised CSM for the site, which is presented on Figure 7.1 and briefly reviewed in the following subsections, identifies those receptors and exposure pathways that realistically may be involved in actual current or hypothetical future exposures. The outcome of the Tier 2 evaluation of site COPCs presented in Section 7.2, and the types of exposures likely to occur at this industrial site, are reflected in this revised CSM. Justification for each site-specific exposure assumption is provided in subsequent discussions.

7.3.1 Sources, Release Mechanisms, and Affected Media

Contamination at the site is present as a result of a surface release at a malfunctioning valve pit. The valve pit was repaired and is currently in use at the site. Therefore, direct release is currently not a potential release mechanism. Mobile, light, non-aqueous phase liquid (LNAPL) (free product) was found at the site in March 1998, and a recently installed free product recovery system is currently in use. Data indicate that the predominant ongoing release mechanism for groundwater contamination is partitioning from mobile and residual LNAPL.

7.3.2 Potentially Exposed Receptors, Exposure Points, and Exposure Routes

The revised CSM for the site also refines the identification of potentially exposed receptor populations, receptor exposure points, and exposure routes for realistic scenarios based on specific site conditions. These components better reflect the likelihood and extent of human or ecological receptor contact with site-related contaminants. As described in Section 2, the site is entirely within the boundaries of the Base. Therefore, potential receptors are limited to the on-Base population. There are no completed pathways to off-Base receptors.

Information resulting from this study indicates that none of the current exposure pathways that are potentially completed are of significance. Results also show that there is only one future potentially completed pathway that could pose a significant risk to potential receptors. Specifically, future indoor receptors may be exposed to soil gas contamination via inhalation of volatilized contaminants if a structure is constructed in the source area. The lack of suitable habitat for animals precludes significant risks to ecological receptors.

7.3.3 Summary of Exposure Pathway Completion

Given the current and planned future uses of the Building 4522 site and the outcome of the chemical fate assessment presented in Section 6, there are no current receptors exposed to contamination at Building 4522, though there are receptors which may be exposed in the future. Onsite intrusive workers and transient wildlife could be exposed to site-related contamination in soil, soil gas, and groundwater during future excavation

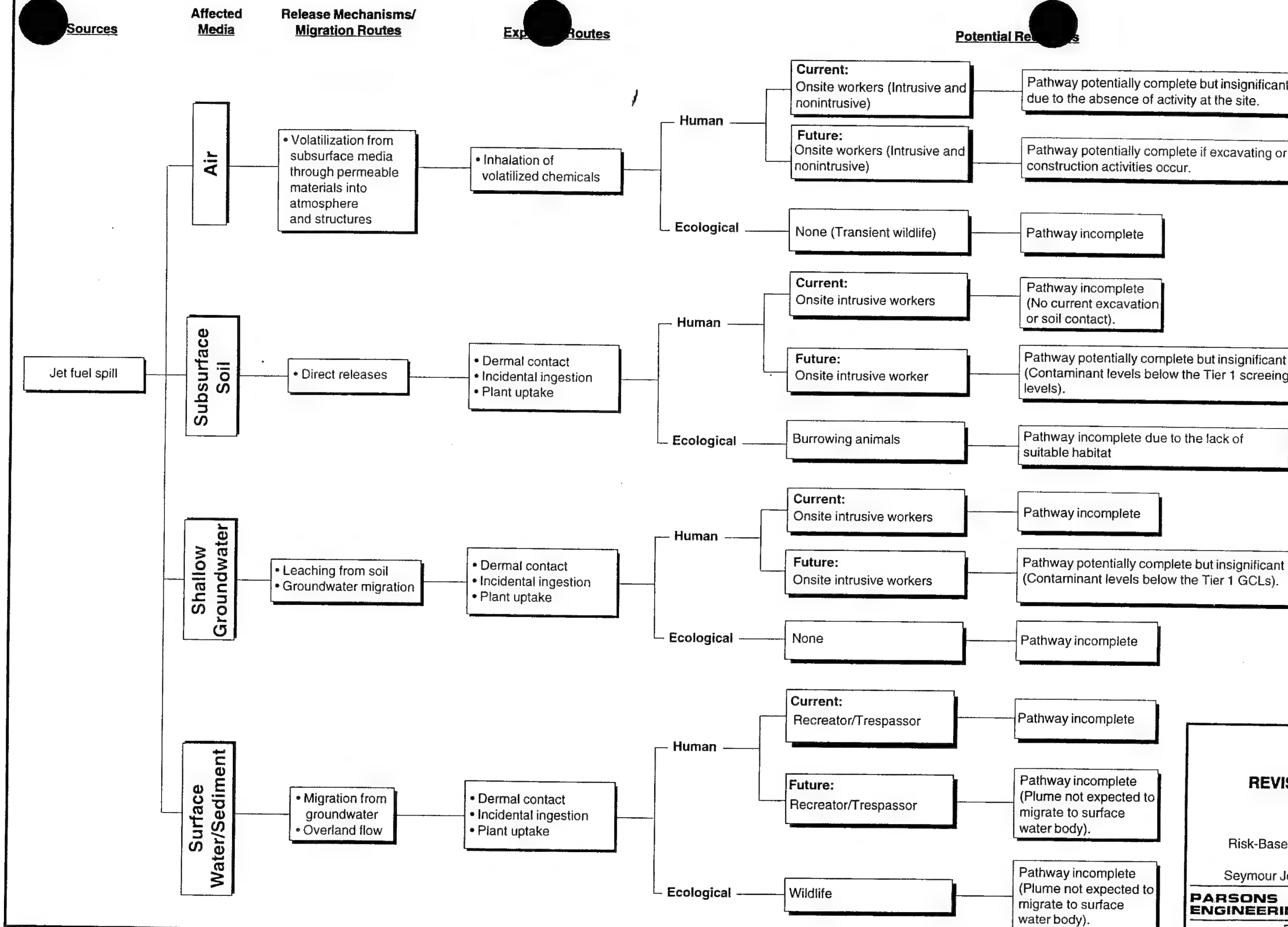


FIGURE 7.1

REVISED CONCEPTUAL SITE MODEL

Risk-Based Approach to Remediation
Building 4522
Seymour Johnson AFB, North Carolina

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

Forms\731854f.pm5 ma 4/99 pg1

activities. Onsite non-intrusive workers could also be exposed in the future to site-related contamination in the breathing zone inside of a permanent structure. This is the only exposure pathway that is potentially significant.

7.4 SUMMARY AND CONCLUSIONS

The following conclusions can be drawn:

- Concentrations of target analytes in soil and surface water samples did not exceed applicable health-protective Tier 1 screening levels; therefore, site soil and surface water contamination does not pose a significant risk to potential receptors under reasonable current and future land use scenarios.

- Although VPH and EPH levels exceeded the interim groundwater standards, these standards are not applicable for this industrial site. There were no exceedences in groundwater of the compound-specific Tier 1 screening levels appropriate for this industrial site.

- Contaminant and geochemical data strongly indicate that biodegradation of fuel hydrocarbons is occurring at the site, primarily via the anaerobic processes of ferric iron reduction and methanogenesis. In addition, the BTEX content of the free product is being reduced over time via weathering, and available free product is being actively recovered.

- Seymour Johnson AFB is an active Base where institutional controls such as land use restrictions, can be maintained with a high level of confidence.

- With the exception of potential future exposure to contaminated soil gas by non-intrusive receptors inside of a permanent structure, none of the potential exposure pathways described in Section 4.4 are considered significant.

The results of this risk-based analysis indicate that this site should be classified as low-risk once recoverable free product has been removed from the subsurface, based on the criteria summarized in Section 1.2.1. Therefore, no further action is recommended, with the exception of continued removal of readily recoverable free product.

SECTION 8

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APPENDIX A

LABORATORY ANALYTICAL DATA

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7.4 SUMMARY AND CONCLUSIONS

The following conclusions can be drawn:

- Concentrations of target analytes in soil and surface water samples did not exceed applicable health-protective Tier 1 screening levels; therefore, site soil and surface water contamination does not pose a significant risk to potential receptors under reasonable current and future land use scenarios.

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- Seymour Johnson AFB is an active Base where institutional controls such as land use restrictions, can be maintained with a high level of confidence.

- With the exception of potential future exposure to contaminated soil gas by non-intrusive receptors inside of a permanent structure, none of the potential exposure pathways described in Section 4.4 are considered significant.

The results of this risk-based analysis indicate that this site should be classified as low-risk once recoverable free product has been removed from the subsurface, based on the criteria summarized in Section 1.2.1. Therefore, no further action is recommended, with the exception of continued removal of readily recoverable free product.

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WORK ORDER #: 9812204

Work Order Summary

CLIENT: Mr. Peter Guest
Parsons Engineering Science, Inc.
1700 Broadway, Suite 900
Denver, CO 80290

BILL TO: Same

PHONE: 303-831-8100
FAX: 303-831-8208
DATE RECEIVED: 12/11/98
DATE COMPLETED: 12/28/98

P.O. # 731854.05000
PROJECT # AFCEE RBCA Investigation

FRACTION #	NAME	TEST	RECEIPT VAC./PRES.
01A	98SJSG-1	TO-3	0.5 "Hg
02A	Lab Blank	TO-3	NA
03A	LCS	TO-3	NA

LAB NARRATIVE:
Compounds detected between the detection limit and the low point on the curve are "J" flagged. Client requested a change in the analyte list from gasoline to JP5 after the sample was analyzed. Consequently, the LCS recovery reported for TPH is that of gasoline, demonstrating instrument stability on the FID detector. In addition, TPH for sample 98SJSG-1 was calculated using the response factor from a single point calibration for JP5 fuel.

CERTIFIED BY: [signature]
Laboratory Director

DATE: 12/28/98

Certification numbers: CA ELAP - 1149, NY ELAP - 11291, UT ELAP - E-217

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SAMPLE NAME : 98SJSG-1

ID#: 9812204-01A

EPA Method TO-3 GC/PID/FID

File Name:	**6121707**	**Date of Collection:**	**12/5/98**
Dil. Factor:	**5120**	**Date of Analysis:**	**12/17/98**

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	5.1	17	260	860
Toluene	5.1	20	59	220
Ethyl Benzene	5.1	23	32	140
Total Xylenes	5.1	23	110 M	480 M
TPH (C2+ Hydrocarbons) ref. to JP5	51	330	110000 B	710000 B

Gasoline recovery from file 6121704.

B = Compound present in laboratory blank, background subtraction not performed.

M = Reported value may be biased due to apparent matrix interferences.

Container Type: 1 Liter Summa Canister

Surrogates	% Recovery	Method Limits
Fluorobenzene (PID)	107	50-150
Fluorobenzene (FID)	108	50-150

AIR TOXICS LTD.

SAMPLE NAME : Lab Blank

ID#: 9812204-02A

EPA Method TO-3 GC/PID/FID

File Name:	6121706	Date of Collection: NA
Dil. Factor:	1.00	Date of Analysis: 12/17/98

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.0010	0.0032	Not Detected	Not Detected
Toluene	0.0010	0.0038	Not Detected	Not Detected
Ethyl Benzene	0.0010	0.0044	Not Detected	Not Detected
Total Xylenes	0.0010	0.0044	Not Detected	Not Detected
TPH (C2+ Hydrocarbons) ref. to JP5	0.010	0.065	0.030	0.19

Container Type: NA

Surrogates	% Recovery	Method Limits
Fluorobenzene (PID)	103	50-150
Fluorobenzene (FID)	99	50-150

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SAMPLE NAME : LCS

ID#: 9812204-03A

EPA Method TO-3 GC/PID/FID

File Name:	6121703	Date of Collection: NA
Dil. Factor:	1.00	Date of Analysis: 12/17/98

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	% Recovery
Benzene	0.0010	0.0032	107
Toluene	0.0010	0.0038	101
Ethyl Benzene	0.0010	0.0044	98
Total Xylenes	0.0010	0.0044	89
TPH (C2+ Hydrocarbons) ref. to Gasoline	0.010	0.042	88

Container Type: NA

Surrogates	% Recovery	Method Limits
Fluorobenzene (PID)	113	50-150
Fluorobenzene (FID)	108	50-150

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CHAIN-OF-CUSTODY RECORD

№ 019020

Page 1 of 1

Contact Person John Hicks
Company Parsons Engineering Science, Inc.
Address 1700 Broadway Suite 900 City Denver State CO Zip 80290
Phone 303-831-8100 FAX 303-831-8208
Collected By: Signature

Project Info:
P.O. # 731854.05000
Project #
Project Name AFCEE RBCA Investigation

Turn Around Time:
☒ Normal
☐ Rush ______ Specify

Lab I.D.	Field Sample I.D.	Date & Time	Analyses Requested	Canister Pressure / Vacuum Initial	Final	Receipt
01A	985JSG-1	12/5/98 1030	TO-3	29.9	0.0	0.5 "Hg

Relinquished By: (Signature) Date/Time 12/10/98 1900 Print Name Tom Dregoo
Relinquished By: (Signature) Date/Time Received By: (Signature) Date/Time
Relinquished By: (Signature) Date/Time Received By: (Signature) Date/Time AT 12/11/98 1015

Notes:

Lab Use Only	Shipper Name	Air Bill #	Opened By:	Date/Time	Temp. (°C)	Condition	Custody Seals Intact? Yes No None N/A	Work Order #
	Fed-ex	544745026	TS	12/11/98 1015	Ambient	Good	None	9812204

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Case Narrative
SDG 122931
12/24/98

Client: **Parsons Engineering Sciences, Inc.**
1700 Broadway, Suite 900
Denver, CO 80290

Client Project Number: 731854.05000 **Matrix: Water/Soil**

Laboratory Project Number: 8639 **Number of Samples: 3 Water/1 Soil**

Date Received: 12/4/98 **Date Collected: 12/3/98**

Sample Receipt

Three water samples and one soil sample were received on 12/4/98 for MADEP VPH and EPH analysis.

VPH

Samples submitted for VPH analysis exhibited acceptable surrogate recoveries. Aqueous matrix spike/matrix spike duplicate (MS/MSD) analysis was conducted on a sample from another delivery group (98POMP8A). Soil MS/MSD analysis was conducted on sample 98SJB2-5. All MS/MSD recoveries and relative percent difference (RPD) values were acceptable for both MS/MSD pairs. The laboratory control samples (LCS) associated with each matrix, were within control. All instrument calibration was within method specified limits.

EPH

Samples submitted for EPH analysis exhibited acceptable surrogate recoveries. Aqueous MS/MSD analysis was conducted on sample 98SJMW-B. Soil sample MS/MSD analysis was conducted on sample 98SJSB3-6. MS and MSD recoveries for the aqueous matrix were outside of acceptable limits for C9-C18 aliphatic and C11-C22 aromatic fractions. RPD values exceeded limits for the C19-C36 aliphatic and C11-C22 aromatic fractions. All soil MS/MSD recoveries and RPD values were within acceptable limits. The LCSs associated each matrix exhibited acceptable recovery of the spiked fuel standard.

Paula Watts

Paula Watts, MS
Technical Services

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615-726-0177 • 1-800-765-0980 • Fax 615-726-3404

SPECIALIZED ASSAYS

Table of Contents
Sample Delivery Group: ~~122431~~ 122931

N 12-24-98

Cooler Receipt Form

[redacted]ent: Parsons

Cooler Received On: 12/4 And Opened On: 12/4/98 By: PAUL R Buckingham

(Signature)

1. Temperature of Cooler when opened 4°C
2. Were custody seals on outside of cooler and intact? .... Yes No
   a. If yes, what kind and where: 2 front/back
   b. Were the signature and date correct? .... Yes No
3. Were custody papers inside cooler? .... Yes No
4. Were custody papers properly filled out (ink, signed, etc)? .... Yes No
5. Did you sign the custody papers in the appropriate place? .... Yes No
6. What kind of packing material was used? bubble wrap
7. Was sufficient ice used (if appropriate)? .... Yes No
8. Did all bottles arrive in good condition (unbroken)? .... Yes No
9. Were all bottle labels complete (#, date, signed, pres, etc)? .... Yes No
10. Did all bottle labels and tags agree with custody papers? .... Yes No
11. Were correct bottles used for the analysis requested? .... Yes No
12. If present, were VOA vials checked for absence of air bubbles and noted if found? ... Yes No
13. Was sufficient amount of sample sent in each bottle? .... Yes No
14. Were correct preservatives used? .... Yes No
15. Corrective action taken, if necessary:
    a. Name of person contacted:
    b. Date

000004

1 From

Date 12-3-98 [redacted]

Sender's Name Tom DRAGOO Phone (303) 831-8100

Dept/Floor/Suite/Room

Company PARSONS ENGINEERING SCIENCE

Address 1700 BROADWAY STE 900

City DENVER State CO Zip 80290

2 Your Internal Billing Reference Information 731854.05000

3 To

Recipient's Name Sample Receiving Phone (615) 726-0177

Dept/Floor/Suite/Room

Company Specialized Assays Environ

Address 2960 Foster Creighton Dr.
(To "HOLD" at FedEx location, print FedEx address here)

City Nashville State TN Zip 37204-3719

For HOLD at FedEx Location check here

☐ Hold Weekday (Not available with FedEx First Overnight)

☐ Hold Saturday (Not available at all locations) (Not available with FedEx First Overnight or FedEx Standard Overnight)

For Saturday Delivery check here

☐ (Extra Charge. Not available to all locations) (Not available with FedEx First Overnight or FedEx Standard Overnight)

5447451170

4a Express Package Service *Packages und*

Delivery commitment may be later in some areas

☒ FedEx Priority Overnight (Next business morning)

☐ FedEx Standard (Next business afterno

☐ FedEx 2Day* (Second business da

☐

EXP SAVER

☐ FedEx First Overnight (Earliest next business morning delivery to select locations) (Higher rates apply)

*FedEx Letter Rate not available. Minimum charge: One pound FedEx 2Day rate

4b Express Freight Service *Packages over 150 lbs.*

Delivery commitment may be later in some areas

☐ FedEx Overnight Freight (Next business day service for any distance)

☐ FedEx 2Day Freight (Second business day service for any distance)

☐ FedEx Express Saver Freight (Up to 3 business day service based upon distance)

(Call for delivery schedule. See back for detailed descriptions of freight products.)

5 Packaging

☐ FedEx Letter

☐ FedEx Pak

Declared value limit $500

☐ FedEx Box

☐ FedEx Tube

☒ Other Pkg.

6 Special Handling

Does this shipment contain dangerous goods?

☐ Yes (As per attached Shipper's Declaration)

☐ Yes (Shipper's Declaration not required)

☐ Dry Ice
Dry Ice, 9, UN 1845 III ______ x ______ kg. 904
(Dangerous Goods Shipper's Declaration not required)

CA ☐ Cargo Aircraft Only

7 Payment

Bill to:

☒ Sender (Account no. in section 1 will be billed)

☐ Recipient

☐ Third Party

☐ Credit Card

☐ Cash/Check

(Enter FedEx account no. or Credit Card no. below)

☐ Obtain Recipient FedEx Account No.

[redacted]

Total Packages 1

Total Weight

Total Declared Value* $ 1,000 .00

Total Charges $

*When declaring a value higher than $100 per shipment, you pay an additional charge. See SERVICE CONDITIONS, DECLARED VALUE AND LIMIT OF LIABILITY section for further information.

Credit Card Auth.

8 Release Signature

Your signature authorizes Federal Express to deliver this shipment without obtaining a signature and agrees to indemnify and hold harmless Federal Express from any resulting claims.

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Call 1·800·Go·FedEx
(1-800-463-3339)

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VPH
Results and Summary Data

Prepared by:

Specialized Assays, Inc.
2960 Foster Creighton Drive
Nashville, TN 37204

(615) 726-0177

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

SAMPLE NO.
98SJMW-4

Lab Name: SPECIALIZED ASSAYS Contract: ______

Lab Code SASSAYS Site: ______ Location: ______ SDG 123931

Matrix: (soil/water) WATER Lab Sample ID: 152207

Sample wt/vol: 5.0 (g/mL) m L Lab File ID: 1215HP12.038

Level: (low/med) N/A Date Received: 12/5/98

% Moisture: not dec. N/A Date Analyzed: 12/16/98

GC Column: DB-VRX ID: 0.53 (mm) Dilution Factor: 10.0

Soil Extract Volume: ______ (uL) Soil Aliquot Volume: ______ (uL)

Concentration Units: (ug/L or ug/Kg) ug/L

CAS No.	Compound	ug/L	Q
	C5-C8	9660	
	C9-C12	2390	
	C9-C10	1180	

C9-C18 12: = 2513
C11-C22 615 = 1795

FORM I VOA 3/90

000007

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

SAMPLE NO.
98SJMP-B

Lab Name: SPECIALIZED ASSAYS Contract: ______

Lab Code SASSAYS Site: ______ Location: ______ SDG 123931

Matrix: (soil/water) WATER Lab Sample ID: 152208

Sample wt/vol: 5.0 (g/mL) m L Lab File ID: 1215HP15.039

Level: (low/med) N/A Date Received: 12/5/98

% Moisture: not dec. N/A Date Analyzed: 12/16/98

GC Column: DB-VRX ID: 0.53 (mm) Dilution Factor: 10.0

Soil Extract Volume: ______ (uL) Soil Aliquot Volume: ______ (uL)

Concentration Units: (ug/L or ug/Kg) ug/L

CAS No.	Compound	ug/L	Q
	C5-C8	12220	
	C9-C12	2400	+
	C9-C10	1120	+

C9-C18 2850 = 5250
C11-C22 1340 = 2460

FORM I VOA

3/90

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Nashville, TN 37204

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1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

SAMPLE NO.
98SJSB3-6

Lab Name: SPECIALIZED ASSAYS Contract:

Lab Code SASSAYS Site: Location: SDG 122931

Matrix: (soil/water) SOIL Lab Sample ID: 152206

Sample wt/vol: 5.0 (g/mL) m L Lab File ID: 1215HP23.027

Level: (low/med) LOW Date Received: 12/5/98

% Moisture: not dec. 0 Date Analyzed: 12/16/98

GC Column: DB-VRX ID: 0.53 (mm) Dilution Factor: 50.0

Soil Extract Volume: (uL) Soil Aliquot Volume: (uL)

Concentration Units: (ug/L or ug/Kg) ug/kg

CAS No.	Compound	ug/kg	Q
	C5-C8	27700	
	C9-C12	97500	+
	C9-C10	61500	+

C9-C18 10,600 = 108,100
C11-C22 10,600 = 72,100

FORM I VOA 3/90

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EPH
Results and Summary Data

Prepared by:

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Nashville, TN 37204

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1A

PETROLEUM HYDROCARBON ANALYSIS DATA SHEET

SAMPLE NO.

98SJMW-4 ALI

ame: SPECIALIZED ASSAYS Contract: ____________

SDG # 122931 Site: ______ Location: ______ Group: ______

Matrix: (soil/water): WATER Lab Sample ID: 152207 ALI

Sample (wt/vol): 1000 (g/mL) mL Lab File ID: 1208SH.020

Level: (low/med) LOW Date Recieved: 12/4/98

%Moisture: non dec. ______ Date Analyzed: 12/9/98

GC Column: DB-1 ID: 0.32 (mm) Dilution Factor: 1

Soil Extract Volume: 1000 (uL) Soil Aliquot Volume: ______ (uL)

Concentration Units: (ug/L or ug/Kg) ug/L

CAS No.	Compound		ug/L	Q
	C9-C18 ALIPHATIC		123	
	C19-C36 ALIPHATIC		100	U

223

000145

1A

PETROLEUM HYDROCARBON ANALYSIS DATA SHEET

SAMPLE NO.

98SJMW-4 ARO

Lab Name: SPECIALIZED ASSAYS Contract: ____

SDG # 122931 Site: ____ Location: ____ Group: ____

Matrix: (soil/water): WATER Lab Sample ID: 152207 ARO

Sample (wt/vol): 1000 (g/mL) mL Lab File ID: 1208SH.021

Level: (low/med) LOW Date Recieved: 12/4/98

%Moisture: non dec. ____ Date Analyzed: 12/9/98

GC Column: DB-1 ID: 0.32 (mm) Dilution Factor: 1

Soil Extract Volume: 1000 (uL) Soil Aliquot Volume: ____ (uL)

Concentration Units: (ug/L or ug/Kg) ug/L

CAS No.	Compound		ug/L	Q
	C11-C22 AROMATIC		615	

000146

1A

PETROLEUM HYDROCARBON ANALYSIS DATA SHEET

SAMPLE NO.

98SJMP-B ALI

L[illegible]me: SPECIALIZED ASSAYS Contract: ______

SDG # 122931 Site: ______ Location: ______ Group: ______

Matrix: (soil/water): WATER Lab Sample ID: 152208 ALI

Sample (wt/vol): 1000 (g/mL) mL Lab File ID: 1208SH.022

Level: (low/med) LOW Date Recieved: 12/4/98

%Moisture: non dec. ______ Date Analyzed: 12/9/98

GC Column: DB-1 ID: 0.32 (mm) Dilution Factor: 1

Soil Extract Volume: 1000 (uL) Soil Aliquot Volume: ______ (uL)

CAS No.	Compound	Concentration Units: (ug/L or ug/Kg) ug/L	Q
	C9-C18 ALIPHATIC	2850	
	C19-C36 ALIPHATIC	100	U

000147

1A
PETROLEUM HYDROCARBON ANALYSIS DATA SHEET

SAMPLE NO.
98SJMP-B ARO

ab Name: SPECIALIZED ASSAYS Contract: ______

SDG # 122931 Site: ______ Location: ______ Group: ______

Matrix: (soil/water): WATER Lab Sample ID: 152208 ARO

Sample (wt/vol): 1000 (g/mL) mL Lab File ID: 1208SH.023

Level: (low/med) LOW Date Recieved: 12/4/98

%Moisture: non dec. ______ Date Analyzed: 12/9/98

GC Column: DB-1 ID: 0.32 (mm) Dilution Factor: 1

Soil Extract Volume: 1000 (uL) Soil Aliquot Volume: ______ (uL)

CAS No.	Compound	Concentration Units: (ug/L or ug/Kg) ug/L	Q
	C11-C22 AROMATIC	1340	

000143

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Nashville, TN 37204

(615) 726-0177

1A

PETROLEUM HYDROCARBON ANALYSIS DATA SHEET

SAMPLE NO.

98SJSB3-6 ALI

Lab Name: SPECIALIZED ASSAYS Contract: ____

SDG # 122931 Site: ____ Location: ____ Group: ____

Matrix: (soil/water): SOIL Lab Sample ID: 152206 ALI

Sample (wt/vol): 10 (g/mL) g Lab File ID: 1214SH.040

Level: (low/med) LOW Date Recieved: 12/4/98

%Moisture: non dec. 6 Date Analyzed: 12/16/98

GC Column: DB-1 ID: 0.32 (mm) Dilution Factor: 1

Soil Extract Volume: 1000 (uL) Soil Aliquot Volume: ____ (uL)

Concentration Units: (ug/L or ug/Kg) ug/Kg

CAS No.	Compound		ug/Kg	Q
	C9-C18 ALIPHATIC		10600	U
	C19-C36 ALIPHATIC		10600	U

Mar-

1A

PETROLEUM HYDROCARBON ANALYSIS DATA SHEET

SAMPLE NO.

98SJSB3-6 ARO

Lab Name: SPECIALIZED ASSAYS Contract: ______

SDG # 122931 Site: ______ Location: ______ Group: ______

Matrix: (soil/water): SOIL Lab Sample ID: 152206 ARO

Sample (wt/vol): 10 (g/mL) g Lab File ID: 1214SH.041

Level: (low/med) LOW Date Recieved: 12/4/98

%Moisture: non dec. 6 Date Analyzed: 12/16/98

GC Column: DB-1 ID: 0.32 (mm) Dilution Factor: 10

Soil Extract Volume: 1000 (uL) Soil Aliquot Volume: ______ (uL)

CAS No.	Compound	Concentration Units: (ug/L or ug/Kg) ug/Kg	Q
	C11-C22 AROMATIC	10600	U

000225

SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.
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Nashville, TN 37204-0566
Phone 1-615-726-0177

PARSONS ENGINEERING SCIENCE 8639

1700 BROADWAY STE 900
DENVER, CO 80290

CHAIN OF CUSTODY

Project Number: 731854.05000 | Sampler: Michael D. Jackson

Project Name: AFCEE RBCA INVE. | SAE Quote:

Analysis Requested

Lab No.	Field Number	Date	Time	Matrix	Grab	Comp	Bottles	MADEP-EPH → MS/MSD	MADEP-VPH → MS/MSD	MADEP-EPH	MADEP-EPH → MSD	MADEP-EPH → MS	MADEP-VPH	MADEP-VPH → MSD	MADEP-VPH →
-A152206	98SJSB3-6	12/3/98	10:30	Soil				X							
	98SJSB3-6b	12/3/98	10:30	Soil					X						
3-A152207	18SJMW-4	12/3/98	9:30	H_2O			1L Amber			X					
-A152208	98SJMP-B	12/3/98	10:10	H_2O			3 bottles ↓ 1L Amber			X	X	X			
2207	98SJMW-4	12/3/98	9:30	H_2O			40ml VOA HCl Pres						X	X	X
152208	98SJMP-B	12/3/98	10:10	H_2O			40ml VOA HCl Pres						X		
3-A152209	TRIP	12/3/98					2 40ml VOAs								
4°C	Temp Blank	12/3/98					500 ml Poly								

Relinquished by:	D/T	Received by:	D/T	Relinquished by:	D/T	Received by:	D/T
[signature]	12-3-98 15:00						
Relinquished by:	D/T	Received by:	D/T	Relinquished by:	D/T	Received by: [signature]	12/4/98 9:00

Cooler Temperature When Received: 4°C

Laboratory Project Number: 122931

Cooler Seals Intact?

Fed-X Air Bill Number:

SPECIAL INSTRUCTIONS:

000003

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Case Narrative
SDG 122569
12/24/98

Client: **Parsons Engineering Sciences, Inc.**
1700 Broadway, Suite 900
Denver, CO 80290

Client Project Number: 731854.05000 **Matrix: Soil**

Laboratory Project Number: 8185 **Number of Samples: 1**

Date Received: 12/3/98 **Date Collected: 12/2/98**

Sample Receipt

One soil sample was received on 12/3/98 for MADEP VPH and EPH analysis.

VPH

The sample submitted for VPH analysis exhibited acceptable surrogate recoveries. Matrix spike/matrix spike duplicate (MS/MSD) analysis was conducted on the sample included in this deliverable. All MS/MSD recoveries and relative percent difference (RPD) values were acceptable. The laboratory control sample (LCS) associated with this delivery group was within control. All instrument calibration was within method specified limits.

EPH

The sample submitted for EPH analysis exhibited acceptable surrogate recoveries in the primary analysis. As expected in the dilution analysis surrogates were diluted out of range. MS/MSD analysis was conducted on sample 98SJSB2-5. The native sample concentration (for sample 98SJSB2-5) required a 10 fold dilution to report target ranges within calibration range. The high native sample concentration caused interference with the MS/MSD recoveries and RPD values. One of six recoveries was acceptable in the MS/MSD pair. Two of the three RPD values exceeded limits. The LCS associated with this batch exhibited acceptable recovery of the spiked fuel standard.

Paula Watts

Paula Watts, MS
Technical Services
Specialized Assays

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SPECIALIZED ASSAYS

Table of Contents
Sample Delivery Group: 122569

Cooler Receipt Form

Client: Parsons

Cooler Received On: 12/3 And Opened On: 12/3/98 By: Paul R Buckingham

PRB

(Signature)

1. Temperature of Cooler when opened 4°C
2. Were custody seals on outside of cooler and intact?............ Yes No
   a. If yes, what kind and where: 2 front/back
   b. Were the signature and date correct?............ Yes No
3. Were custody papers inside cooler?............ Yes No
4. Were custody papers properly filled out (ink, signed, etc)?............ Yes No
5. Did you sign the custody papers in the appropriate place?............ Yes No
6. What kind of packing material was used? bubble wrap
7. Was sufficient ice used (if appropriate)?............ Yes No
8. Did all bottles arrive in good condition (unbroken)?............ Yes No
9. Were all bottle labels complete (#, date, signed, pres, etc)?............ Yes No
10. Did all bottle labels and tags agree with custody papers?............ Yes No
11. Were correct bottles used for the analysis requested?............ Yes No
12. If present, were VOA vials checked for absence of air bubbles and noted if found?............ Yes No
13. Was sufficient amount of sample sent in each bottle?............ Yes No
14. Were correct preservatives used?............ Yes No
15. Corrective action taken, if necessary:
    a. Name of person contacted:
    b. Date

000003A

000043B

SNA12

FedEx. USA Airbill

FedEx Tracking Number 808923573203

Form I.D. No. 0210

Recipient's Copy

1 From

Date 12/2/98 [redacted]

Sender's Name TOM DRAGOO Phone ( )

Company Parsons Engineering Science, Inc

Address 1700 Broadway Suite 900 Dept./Floor/Suite/Room

City Denver State CO ZIP 80290

2 Your Internal Billing Reference Information

3 To

Recipient's Name SAMPLE RECEIVING Phone (615) 726-0177

Company SPECIALIZED ASSAYS ENVIRON ☐ Check here if residence (Extra charge applies for FedEx Express Saver)

Address 2960 FOSTER CREIGHTON DR Dept./Floor/Suite/Room
(To "HOLD" at FedEx location, print FedEx address here)

City NASHVILLE State TN ZIP 37204-3719

For HOLD at FedEx Location check here
☐ Hold Weekday (Not available with FedEx First Overnight)
☐ Hold Saturday (Not available at all locations) (Available for FedEx Priority Overnight and FedEx 2Day only)

For WEEKEND Delivery check here (Extra Charge. Not available at all locations)
☐ Saturday Delivery (Available for FedEx Priority Overnight and FedEx 2Day only)
☐ NEW Sunday Delivery (Available for FedEx Priority Overnight only)

4a Express Package Service *Packages under 150 lbs.* Delivery commitment may be later in some areas.
☒ FedEx Priority Overnight (Next business morning)
☒ FedEx Standard Overnight (Next business afternoon)
☐ FedEx First Overnight (Earliest next business morning delivery to select locations) (Higher rates apply)
☐ FedEx 2Day (Second business day)
☐ FedEx Express Saver (Third business day)
FedEx Letter Rate not available. Minimum charge: One pound rate.

4b Express Freight Service *Packages over 150 lbs.* Delivery commitment may be later in some areas.
☐ FedEx Overnight Freight (Next business day)
☐ FedEx 2Day Freight (Second business day)
☐ FedEx Express Saver Freight (Up to 3 business days)
(Call for delivery schedule. See back for detailed descriptions of freight services.)

5 Packaging
☐ FedEx Letter ☐ FedEx Pak (Declared value limit $500) ☐ FedEx Box ☐ FedEx Tube ☒ Other Pkg.

6 Special Handling
Does this shipment contain dangerous goods?* (One box must be checked)
☐ No ☐ Yes (As per attached Shipper's Declaration) ☐ Yes (Shipper's Declaration not required)
☐ Dry Ice (Dry Ice, 9, UN 1845 ____ x ____ kg.)
☐ Cargo Aircraft Only
*Dangerous Goods cannot be shipped in FedEx packaging.

7 Payment
Bill to: ☒ Sender (Account No. in Section 1 will be billed) ☒ Recipient ☐ Third Party ☐ Credit Card ☐ Cash/Check ☐ Obtain Recipient FedEx Account No.
(Enter FedEx Account No. or Credit Card No. below)

[redacted]

Total Packages	Total Weight	Total Declared Value*	Total Charges
1	10	$ 250 .00	$

Credit Card Auth.

*When declaring a value higher than $100 per shipment, you pay an additional charge. See SERVICE CONDITIONS, DECLARED VALUE, AND LIMIT OF LIABILITY section for further information.

8 Release Signature

Your signature authorizes Federal Express to deliver this shipment without obtaining a signature and agrees to indemnify and hold harmless Federal Express from any resulting claims.

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VPH
Results and Summary Data

Prepared by:

Specialized Assays, Inc.
2960 Foster Creighton Drive
Nashville, TN 37204

(615) 726-0177

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

SAMPLE NO.
98SJB2-5

Lab Name: SPECIALIZED ASSAYS Contract: ______

Lab Code SASSAYS Site: ______ Location: ______ SDG 122569

Matrix: (soil/water) ~~WATER~~ Soil 12-24-98 Lab Sample ID: 150508

Sample wt/vol: 5.0 (g/mL) ~~mL~~ g Lab File ID: 1215HP15.022

Level: (low/med) N/A Date Received: 12/3/98

% Moisture: not dec. N/A Date Analyzed: 12/16/98

GC Column: DB-VRX ID: 0.53 (mm) Dilution Factor: 5000.0

Soil Extract Volume: ______ (uL) Soil Aliquot Volume: ______ (uL)

CAS No.	Compound	Concentration Units: (ug/L or ug/Kg) ug/Kg	Q
VPH	C5-C8	10000	U
	C9-C12	18400	
VPH/EPH	C9-~~C10~~ -C11	11400	

+ C11-C22 = 1,071,400 ☆

FORM I VOA 3/90

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EPH
Results and Summary Data

Prepared by:

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2960 Foster Creighton Drive
Nashville, TN 37204

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000071

1A

PETROLEUM HYDROCARBON ANALYSIS DATA SHEET

SAMPLE NO.

98SJSB2-5 A

Lab Name: SPECIALIZED ASSAYS Contract: ____

SDG # 122569 Site: ____ Location: ____ Group: ____

Matrix: (soil/water): SOIL Lab Sample ID: 150508 ALI

Sample (wt/vol): 10 (g/mL) g Lab File ID: 1210SH.030

Level: (low/med) LOW Date Recieved: 12/3/98

%Moisture: non dec. 14 Date Analyzed: 12/11/98

GC Column: DB-1 ID: 0.32 (mm) Dilution Factor: 1

Soil Extract Volume: 1000 (uL) Soil Aliquot Volume: ____ (uL)

CAS No.	Compound	Concentration Units: (ug/L or ug/Kg) ug/Kg	Q
	C9-C18 ALIPHATIC	3070000	E
	C19-C36 ALIPHATIC	14500	

1A

PETROLEUM HYDROCARBON ANALYSIS DATA SHEET

SAMPLE NO.

98SJSB2-5 ALI DL

Lab Name: SPECIALIZED ASSAYS Contract: ______

SDG # 122569 Site: ______ Location: ______ Group: ______

Matrix: (soil/water): SOIL Lab Sample ID: 150508 ALI X10

Sample (wt/vol): 10 (g/mL) g Lab File ID: 1210SH.032

Level: (low/med) LOW Date Recieved: 12/3/98

%Moisture: non dec. 14 Date Analyzed: 12/11/98

GC Column: DB-1 ID: 0.32 (mm) Dilution Factor: 10

Soil Extract Volume: 1000 (uL) Soil Aliquot Volume: ______ (uL)

Concentration Units: (ug/L or ug/Kg) ug/Kg

CAS No.	Compound			Q
	C9-C18 ALIPHATIC	+ C9-C12 18,400	3170000	
	C19-C36 ALIPHATIC		11600	U

= 3,188,400

1A

PETROLEUM HYDROCARBON ANALYSIS DATA SHEET

SAMPLE NO.

98SJSB2-5 ARO

Lab Name: SPECIALIZED ASSAYS Contract: ____________

SDG # 122569 Site: ______ Location: ______ Group: ______

Matrix: (soil/water): SOIL Lab Sample ID: 150508 ARO X10

Sample (wt/vol): 10 (g/mL) g Lab File ID: 1210SH.033

Level: (low/med) LOW Date Recieved: 12/3/98

%Moisture: non dec. 14 Date Analyzed: 12/11/98

GC Column: DB-1 ID: 0.32 (mm) Dilution Factor: 10

Soil Extract Volume: 1000 (uL) Soil Aliquot Volume: ______ (uL)

CAS No.	Compound	Concentration Units: (ug/L or ug/Kg) ug/Kg	Q
	C11-C22 AROMATIC	1060,000	
	C9-C10	11,400	
		1,071,400	

000074

SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.
P.O. Box 40566
Nashville, TN 37204-0566
Phone 1-615-726-0177

PARSONS ENGINEERING/AFCEE EXT 8185
JOHN RATZ
1700 BROADWAY STE 900
DENVER, CO 80290

CHAIN OF CUSTODY

Project Number: 731854.05000
Sampler: T. DRAGOO
Project Name: AFCEE-RBCA Investigation
SAE Quote:

Analysis Requested

Lab No.	Field Number	Date	Time	Matrix	Grab	Comp	Bottles		MADEP VPH	MADEP EPH					
18SJSB2-5	SB2	12/2/98	1200	Soil	Encore				X						
18SJSB2-5	SB2	12/2/98	1200	Soil			4 oz			X	98-A150508				

Relinquished by:	D/T	Received by:	D/T	Relinquished by:	D/T	Received by:	D/T
Tom Dragoo	12/2/98 1500						
Relinquished by:	D/T	Received by:	D/T	Relinquished by:	D/T	Received by:	D/T 12/3/98 1100

Cooler Temperature When Received: 4°C	SPECIAL INSTRUCTIONS: 24 ~~hrs~~ hour hold time for VPH analysis.
Laboratory Project Number: 1225269	
Seals Intact?	000003
Fed-X Air Bill Number: 808923573203	

COPY 1

Quanterra

Quanterra Incorporated
4955 Yarrow Street
Arvada, Colorado 80002

303 421-6611 Telephone
303 431-7171 Fax

ANALYTICAL REPORT

Seymour Johnson AFB
Lot #: D8L090209

John Hicks

Parsons Engineering Services

QUANTERRA INCORPORATED

Ellen La Riviere

Ellen La Riviere
Project Manager

January 19, 1999

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C.	• Semivolatile GC/MS	
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Project Narrative
(D8L090209)

GC/MS Semi-Volatiles

Problem Description

The extraction lab ran out of all analyte spike, and it was not possible to obtain a new supply prior to sample expiration. Therefore, an expired all analyte spike standard (V11292) was used to prepare the LCS/LCSD and MS/MSD for QC Batch 8344205. The expired standard was re-verified, but the re-verification showed that Benzidine and 3,3'-Dichlorobenzidine had degraded and were no longer present in the expired standard.

The MS is the primary control sample for method 625. The LCS is used as a backup for the MS.

As expected, the recoveries of Benzidine and 3,3'-Dichlorobenzidine were out of control in the MS/MSD associated with sample D8L090209-03. The LCS/LCSD associated with these samples was also out-of-control for Benzidine and 3,3'-Dichlorobenzidine. Since it can be shown that these compounds were out-of-control because the spiking standard had degraded, no corrective action was taken.

The relative percent differences for 1,2-diphenylhydrazine, hexachlorocyclopentadiene and H-nitrosodiphenylamine also exceeded the control limits in the LCS/LCSD associated with the Method 625 batch 8344205. Because these compounds were within acceptable limits in the MS/MSD, no further action was required by the Method.

Polynuclear Aromatic Hydrocarbons

Dibenzo(a,h)anthracene was recovered above the upper control limits in the LCS/LCSD associated with the sample in this project. Because this would indicate a high bias to the data, and this compound was not detected in the samples, no further action was required.

Methane by RSK-175

The methane analysis by RSK-175 was performed by Quanterra's laboratory located in Austin, Texas.

Samples D8L090209-002 and –008 were originally analyzed undiluted. Methane was detected at a concentration above the linear calibration range of the instrument and have been reported with "E flags." The samples were reanalyzed at the appropriate dilutions. Both sets of data have been reported.

EXECUTIVE SUMMARY - Detection Highlights

D8L090209

PARAMETER	RESULT	REPORTING LIMIT	UNITS	ANALYTICAL METHOD
98SJ MW-2 12/03/98 12:10 001				
Methane	3.4 B	0.50	ug/L	EPA-9 RSK-175
98SJ MW-4 12/03/98 09:30 002				
Benzene	1300	25	ug/L	CFR136A 602
Benzene	1300	25	ug/L	CFR136A 602
Benzene	1300	25	ug/L	CFR136A 602
Ethylbenzene	620	25	ug/L	CFR136A 602
Ethylbenzene	620	25	ug/L	CFR136A 602
Ethylbenzene	650	25	ug/L	CFR136A 602
Toluene	2200 B	25	ug/L	CFR136A 602
Toluene	2200 B	25	ug/L	CFR136A 602
Toluene	2200 B	25	ug/L	CFR136A 602
Xylenes (total)	2300	25	ug/L	CFR136A 602
Xylenes (total)	2300	25	ug/L	CFR136A 602
Xylenes (total)	2300	25	ug/L	CFR136A 602
Methane	410 B,E	0.50	ug/L	EPA-9 RSK-175
Methane	1700 B,D	25	ug/L	EPA-9 RSK-175
98SJ MW-5 12/03/98 11:30 003				
Methyl tert-butyl ether	0.21 J	5.0	ug/L	CFR136A 602
Methyl tert-butyl ether	0.21 J	5.0	ug/L	CFR136A 602
Methyl tert-butyl ether	0.22 J	5.0	ug/L	CFR136A 602
Methane	0.31 J,B	0.50	ug/L	EPA-9 RSK-175
98SJ MW-6 12/02/98 08:00 004				
Benzene	570	12	ug/L	CFR136A 602
Benzene	570	12	ug/L	CFR136A 602
Benzene	570	12	ug/L	CFR136A 602
98SJ MW-7 12/04/98 13:10 005				
Benzene	5.8	0.50	ug/L	CFR136A 602
Benzene	5.8	0.50	ug/L	CFR136A 602
Benzene	5.8	0.50	ug/L	CFR136A 602
Ethylbenzene	2.4	0.50	ug/L	CFR136A 602
Ethylbenzene	2.4	0.50	ug/L	CFR136A 602
Ethylbenzene	2.5	0.50	ug/L	CFR136A 602
Toluene	5.0 B	0.50	ug/L	CFR136A 602
Toluene	5.0 B	0.50	ug/L	CFR136A 602
Toluene	3.0 B	0.50	ug/L	CFR136A 602

(Continued on next page)

EXECUTIVE SUMMARY - Detection Highlights

D8L090209

PARAMETER	RESULT	REPORTING LIMIT	UNITS	ANALYTICAL METHOD
98SJ MW-7 12/04/98 13:10 005				
Xylenes (total)	23	0.50	ug/L	CFR136A 602
Xylenes (total)	23	0.50	ug/L	CFR136A 602
Xylenes (total)	24	0.50	ug/L	CFR136A 602
98SJ MW-8 12/04/98 13:30 006				
Toluene	0.29 J,B	0.50	ug/L	CFR136A 602
Toluene	0.29 J,B	0.50	ug/L	CFR136A 602
Toluene	0.17 J,B	0.50	ug/L	CFR136A 602
98SJ MP-A 12/04/98 13:50 007				
Benzene	0.76	0.50	ug/L	CFR136A 602
Benzene	0.76	0.50	ug/L	CFR136A 602
Benzene	0.66	0.50	ug/L	CFR136A 602
Methyl tert-butyl ether	1.5 J	5.0	ug/L	CFR136A 602
Methyl tert-butyl ether	1.5 J	5.0	ug/L	CFR136A 602
Methyl tert-butyl ether	1.2 J	5.0	ug/L	CFR136A 602
98SJ MP-B 12/03/98 10:10 008				
Benzene	980	50	ug/L	CFR136A 602
Benzene	980	50	ug/L	CFR136A 602
Benzene	940	50	ug/L	CFR136A 602
Ethylbenzene	440	50	ug/L	CFR136A 602
Ethylbenzene	440	50	ug/L	CFR136A 602
Ethylbenzene	450	50	ug/L	CFR136A 602
Toluene	2800 B	50	ug/L	CFR136A 602
Toluene	2800 B	50	ug/L	CFR136A 602
Toluene	2900 B	50	ug/L	CFR136A 602
Xylenes (total)	1800	50	ug/L	CFR136A 602
Xylenes (total)	1800	50	ug/L	CFR136A 602
Xylenes (total)	1800	50	ug/L	CFR136A 602
Methane	340 B,E	0.50	ug/L	EPA-9 RSK-175
Methane	1200 B,D	10	ug/L	EPA-9 RSK-175
TRIP BLANK 12/04/98 011				
Methane	0.18 J,B	0.50	ug/L	EPA-9 RSK-175

METHOD / ANALYST SUMMARY

D8L090209

ANALYTICAL METHOD	ANALYST	ANALYST ID
CFR136A 602	Shawn Hadley	060376
CFR136A 625	Robert P. Guthrie	001593
EPA-9 RSK-175	Brook Derenzy	005830
SW846 8310	Dane Rodgers	007407

References:

CFR136A "Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater", 40CFR, Part 136, Appendix A, October 26, 1984 and subsequent revisions.

EPA-9 Sample Prep and Calculations for Dissolved Gas Analysis in Water Samples Using a GC Headspace Equilibration Technique, RSKSOP-175, REV. 0, 8/11/94, USEPA Research Lab

SW846 "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 and its updates.

SAMPLE SUMMARY

D8L090209

WO #	SAMPLE#	CLIENT SAMPLE ID	DATE	TIME
CP5JV	001	98SJ MW-2	12/03/98	12:10
CP5JX	002	98SJ MW-4	12/03/98	09:30
CP5K2	003	98SJ MW-5	12/03/98	11:30
CP5K3	004	98SJ MW-6	12/02/98	08:00
CP5K4	005	98SJ MW-7	12/04/98	13:10
CP5K6	006	98SJ MW-8	12/04/98	13:30
CP5K8	007	98SJ MP-A	12/04/98	13:50
CP5K9	008	98SJ MP-B	12/03/98	10:10
CP5KA	009	98SJ SW-1	12/04/98	11:30
CP5KC	010	98SJ SW-2	12/04/98	10:30
CP5KM	011	TRIP BLANK	12/04/98	

NOTE(S):

- The analytical results of the samples listed above are presented on the following pages.
- All calculations are performed before rounding to avoid round-off errors in calculated results.
- Results noted as "ND" were not detected at or above the stated limit.
- This report must not be reproduced, except in full, without the written approval of the laboratory.
- Results for the following parameters are never reported on a dry weight basis: color, corrosivity, density, flashpoint, ignitability, layers, odor, paint filter test, pH, porosity pressure, reactivity, redox potential, specific gravity, spot tests, solids, solubility, temperature, viscosity, and weight.

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJ MW-5

GC/MS Semivolatiles

Lot-Sample #...: D8L090209-003 Work Order #...: CP5K2102 Matrix.........: WG
Date Sampled...: 12/03/98 11:30 Date Received..: 12/09/98
Prep Date......: 12/10/98 Analysis Date..: 01/14/99
Prep Batch #...: 8344205 Analysis Time..: 04:51
Dilution Factor: 1
Method.........: CFR136A 625

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Acenaphthene	ND	10	ug/L
Acenaphthylene	ND	10	ug/L
Anthracene	ND	10	ug/L
Benzidine	ND	100	ug/L
Benzo(a)anthracene	ND	10	ug/L
Benzo(b)fluoranthene	ND	10	ug/L
Benzo(ghi)perylene	ND	10	ug/L
Benzo(k)fluoranthene	ND	10	ug/L
Benzo(a)pyrene	ND	10	ug/L
4-Bromophenyl phenyl ether	ND	10	ug/L
Butyl benzyl phthalate	ND	10	ug/L
bis(2-Chloroethoxy) methane	ND	10	ug/L
bis(2-Chloroethyl) ether	ND	10	ug/L
bis(2-Chloroisopropyl) ether	ND	10	ug/L
4-Chloro-3-methylphenol	ND	10	ug/L
2-Chloronaphthalene	ND	10	ug/L
2-Chlorophenol	ND	10	ug/L
4-Chlorophenyl phenyl ether	ND	10	ug/L
Chrysene	ND	10	ug/L
Di-n-butyl phthalate	ND	10	ug/L
1,2-Dichlorobenzene	ND	10	ug/L
1,3-Dichlorobenzene	ND	10	ug/L
1,4-Dichlorobenzene	ND	10	ug/L
3,3'-Dichlorobenzidine	ND	50	ug/L
2,4-Dichlorophenol	ND	10	ug/L
Diethyl phthalate	ND	10	ug/L
2,4-Dimethylphenol	ND	10	ug/L
Dimethyl phthalate	ND	10	ug/L
2,4-Dinitrophenol	ND	50	ug/L
2,4-Dinitrotoluene	ND	10	ug/L
2,6-Dinitrotoluene	ND	10	ug/L
Di-n-octyl phthalate	ND	10	ug/L
1,2-Diphenylhydrazine	ND	10	ug/L
bis(2-Ethylhexyl) phthalate	ND	10	ug/L

(Continued on next page)

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJ MW-5

GC/MS Semivolatiles

Lot-Sample #...: D8L090209-003 Work Order #...: CP5K2102 Matrix.........: WG

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Fluoranthene	ND	10	ug/L
Fluorene	ND	10	ug/L
Hexachlorobenzene	ND	10	ug/L
Hexachlorobutadiene	ND	10	ug/L
Hexachlorocyclopentadiene	ND	50	ug/L
Hexachloroethane	ND	10	ug/L
Indeno(1,2,3-cd)pyrene	ND	10	ug/L
Isophorone	ND	10	ug/L
Naphthalene	ND	10	ug/L
Nitrobenzene	ND	10	ug/L
2-Nitrophenol	ND	10	ug/L
4-Nitrophenol	ND	50	ug/L
N-Nitrosodimethylamine	ND	10	ug/L
N-Nitrosodi-n-propylamine	ND	10	ug/L
N-Nitrosodiphenylamine	ND	10	ug/L
Pentachlorophenol	ND	50	ug/L
Phenanthrene	ND	10	ug/L
Phenol	ND	10	ug/L
Pyrene	ND	10	ug/L
1,2,4-Trichlorobenzene	ND	10	ug/L
2,4,6-Trichlorophenol	ND	10	ug/L

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
2-Fluorophenol	82	(48 - 102)
Phenol-d5	91	(46 - 110)
Nitrobenzene-d5	71	(51 - 102)
2-Fluorobiphenyl	67	(39 - 91)
2,4,6-Tribromophenol	94	(38 - 120)
Terphenyl-d14	69	(42 - 131)

PARSONS ENGINEERING SCIENCE, INC.

98SJ MW-5

GC/MS Semivolatiles

Lot-Sample #: D8L090209-003 Work Order #: CP5K2102 Matrix: WG

MASS SPECTROMETER/DATA SYSTEM (MSDS) TENTATIVELY IDENTIFIED COMPOUNDS

PARAMETER	CAS #	ESTIMATED RESULT	RETENTION TIME	UNITS
None				ug/L

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJ MW-2

GC Volatiles

Lot-Sample #...:	D8L090209-001	Work Order #...:	CP5JV101	Matrix.........:	WG
Date Sampled...:	12/03/98 12:10	Date Received..:	12/09/98		
Prep Date......:	12/11/98	Analysis Date..:	12/11/98		
Prep Batch #...:	8346112	Analysis Time..:	16:03		
Dilution Factor:	1				
		Method.........:	CFR136A 602		

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Benzene	ND	0.50	ug/L
Chlorobenzene	ND	0.50	ug/L
1,2-Dichlorobenzene	ND	0.50	ug/L
1,3-Dichlorobenzene	ND	0.50	ug/L
1,4-Dichlorobenzene	ND	0.50	ug/L
Ethylbenzene	ND	0.50	ug/L
Methyl tert-butyl ether	ND	5.0	ug/L
Toluene	ND	0.50	ug/L
Xylenes (total)	ND	0.50	ug/L

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
a,a,a-Trifluorotoluene (TFT)	95	(82 - 112)

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJ MW-4

GC Volatiles

Lot-Sample #...:	D8L090209-002	Work Order #...:	CP5JX101	Matrix.........:	WG
Date Sampled...:	12/03/98 09:30	Date Received..:	12/09/98		
Prep Date......:	12/11/98	Analysis Date..:	12/11/98		
Prep Batch #...:	8346112	Analysis Time..:	16:39		
Dilution Factor:	50				
		Method.........:	CFR136A 602		

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Benzene	1300	25	ug/L
Chlorobenzene	ND	25	ug/L
1,2-Dichlorobenzene	ND	25	ug/L
1,3-Dichlorobenzene	ND	25	ug/L
1,4-Dichlorobenzene	ND	25	ug/L
Ethylbenzene	620	25	ug/L
Methyl tert-butyl ether	ND	250	ug/L
Toluene	2200 B	25	ug/L
Xylenes (total)	2300	25	ug/L

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
a,a,a-Trifluorotoluene (TFT)	100	(82 - 112)

TE(S):

Method blank contamination. The associated method blank contains the target analyte at a reportable level.

1C

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJ MW-4

GC Volatiles

Lot-Sample #...: D8L090209-002 Work Order #...: CP5JX103 Matrix.........: WG
Date Sampled...: 12/03/98 09:30 Date Received..: 12/09/98
Prep Date......: 12/11/98 Analysis Date..: 12/11/98
Prep Batch #...: 8346112 Analysis Time..: 16:39
Dilution Factor: 50

Method.........: CFR136A 602

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Benzene	1300	25	ug/L
Chlorobenzene	ND	25	ug/L
1,2-Dichlorobenzene	ND	25	ug/L
1,3-Dichlorobenzene	ND	25	ug/L
1,4-Dichlorobenzene	ND	25	ug/L
Ethylbenzene	650	25	ug/L
Methyl tert-butyl ether	ND	250	ug/L
Toluene	2200 B	25	ug/L
Xylenes (total)	2300	25	ug/L

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
a,a,a-Trifluorotoluene (TFT)	95	(82 - 112)

NOTE(S):

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

2C

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJ MW-5

GC Volatiles

Lot-Sample #...:	D8L090209-003	Work Order #...:	CP5K2106	Matrix.........:	WG
Date Sampled...:	12/03/98 11:30	Date Received..:	12/09/98		
Prep Date......:	12/11/98	Analysis Date..:	12/11/98		
Prep Batch #...:	8346112	Analysis Time..:	17:50		
Dilution Factor:	1				
		Method.........:	CFR136A 602		

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Benzene	ND	0.50	ug/L
Chlorobenzene	ND	0.50	ug/L
1,2-Dichlorobenzene	ND	0.50	ug/L
1,3-Dichlorobenzene	ND	0.50	ug/L
1,4-Dichlorobenzene	ND	0.50	ug/L
Ethylbenzene	ND	0.50	ug/L
Methyl tert-butyl ether	**0.22 J**	**5.0**	**ug/L**
Toluene	ND	0.50	ug/L
Xylenes (total)	ND	0.50	ug/L

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
a,a,a-Trifluorotoluene (TFT)	94	(82 - 112)

NOTE(S):

J Estimated result. Result is less than RL.

2C

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJ MW-6

GC Volatiles

Lot-Sample #...: D8L090209-004	Work Order #...: CP5K3101	Matrix.........: WG
Date Sampled...: 12/02/98 08:00	Date Received..: 12/09/98	
Prep Date......: 12/11/98	Analysis Date..: 12/11/98	
Prep Batch #...: 8346112	Analysis Time..: 18:26	
Dilution Factor: 25		
	Method.........: CFR136A 602	

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Benzene	**570**	**12**	**ug/L**
Chlorobenzene	ND	12	ug/L
1,2-Dichlorobenzene	ND	12	ug/L
1,3-Dichlorobenzene	ND	12	ug/L
1,4-Dichlorobenzene	ND	12	ug/L
Ethylbenzene	ND	12	ug/L
Methyl tert-butyl ether	ND	120	ug/L
Toluene	ND	12	ug/L
Xylenes (total)	ND	12	ug/L

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
a,a,a-Trifluorotoluene (TFT)	92	(82 - 112)

NOTE(S):

1C

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJ MW-6

GC Volatiles

Lot-Sample #...:	D8L090209-004	Work Order #...:	CP5K3102	Matrix.........:	WG
Date Sampled...:	12/02/98 08:00	Date Received..:	12/09/98		
Prep Date......:	12/11/98	Analysis Date..:	12/11/98		
Prep Batch #...:	8346112	Analysis Time..:	18:26		
Dilution Factor:	25				
		Method.........:	CFR136A 602		

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Benzene	**570**	**12**	**ug/L**
Chlorobenzene	ND	12	ug/L
1,2-Dichlorobenzene	ND	12	ug/L
1,3-Dichlorobenzene	ND	12	ug/L
1,4-Dichlorobenzene	ND	12	ug/L
Ethylbenzene	ND	12	ug/L
Methyl tert-butyl ether	ND	120	ug/L
Toluene	ND	12	ug/L
Xylenes (total)	ND	12	ug/L

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
a,a,a-Trifluorotoluene (TFT)	94	(82 - 112)

TE(S):

2C

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJ MW-7

GC Volatiles

Lot-Sample #...: D8L090209-005 Work Order #...: CP5K4101 Matrix..........: WG
Date Sampled...: 12/04/98 13:10 Date Received..: 12/09/98
Prep Date......: 12/11/98 Analysis Date..: 12/11/98
Prep Batch #...: 8346112 Analysis Time..: 19:02
Dilution Factor: 1

Method..........: CFR136A 602

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Benzene	**5.8**	**0.50**	**ug/L**
Chlorobenzene	ND	0.50	ug/L
1,2-Dichlorobenzene	ND	0.50	ug/L
1,3-Dichlorobenzene	ND	0.50	ug/L
1,4-Dichlorobenzene	ND	0.50	ug/L
Ethylbenzene	**2.4**	**0.50**	**ug/L**
Methyl tert-butyl ether	ND	5.0	ug/L
Toluene	**5.0 B**	**0.50**	**ug/L**
Xylenes (total)	**23**	**0.50**	**ug/L**

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
a,a,a-Trifluorotoluene (TFT)	99	(82 - 112)

NOTE(S):

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

1C

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJ MW-7

GC Volatiles

Lot-Sample #...: D8L090209-005	Work Order #...: CP5K4102		Matrix..........: WG
Date Sampled...: 12/04/98 13:10	Date Received..: 12/09/98		
Prep Date......: 12/11/98	Analysis Date..: 12/11/98		
Prep Batch #...: 8346112	Analysis Time..: 19:02		
Dilution Factor: 1			
	Method.........: CFR136A 602		

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Benzene	**5.8**	**0.50**	**ug/L**
Chlorobenzene	ND	0.50	ug/L
1,2-Dichlorobenzene	ND	0.50	ug/L
1,3-Dichlorobenzene	ND	0.50	ug/L
1,4-Dichlorobenzene	ND	0.50	ug/L
Ethylbenzene	**2.5**	**0.50**	**ug/L**
Methyl tert-butyl ether	ND	5.0	ug/L
Toluene	**3.0 B**	**0.50**	**ug/L**
Xylenes (total)	**24**	**0.50**	**ug/L**

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
a,a,a-Trifluorotoluene (TFT)	93	(82 - 112)

E(S):

Method blank contamination. The associated method blank contains the target analyte at a reportable level.

2C

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJ MW-8

GC Volatiles

Lot-Sample #...:	D8L090209-006	Work Order #...:	CP5K6102	Matrix.........:	WG
Date Sampled...:	12/04/98 13:30	Date Received..:	12/09/98		
Prep Date......:	12/11/98	Analysis Date..:	12/11/98		
Prep Batch #...:	8346112	Analysis Time..:	19:37		
Dilution Factor:	1				
		Method.........:	CFR136A 602		

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Benzene	ND	0.50	ug/L
Chlorobenzene	ND	0.50	ug/L
1,2-Dichlorobenzene	ND	0.50	ug/L
1,3-Dichlorobenzene	ND	0.50	ug/L
1,4-Dichlorobenzene	ND	0.50	ug/L
Ethylbenzene	ND	0.50	ug/L
Methyl tert-butyl ether	ND	5.0	ug/L
Toluene	**0.17 J,B**	**0.50**	**ug/L**
Xylenes (total)	ND	0.50	ug/L

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
a,a,a-Trifluorotoluene (TFT)	94	(82 - 112)

NOTE(S):

J Estimated result. Result is less than RL.

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

2C

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJ MW-8

GC Volatiles

Lot-Sample #...:	D8L090209-006	Work Order #...:	CP5K6101	Matrix.........:	WG
Date Sampled...:	12/04/98 13:30	Date Received..:	12/09/98		
Prep Date......:	12/11/98	Analysis Date..:	12/11/98		
Prep Batch #...:	8346112	Analysis Time..:	19:37		
Dilution Factor:	1				
		Method.........:	CFR136A 602		

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Benzene	ND	0.50	ug/L
Chlorobenzene	ND	0.50	ug/L
1,2-Dichlorobenzene	ND	0.50	ug/L
1,3-Dichlorobenzene	ND	0.50	ug/L
1,4-Dichlorobenzene	ND	0.50	ug/L
Ethylbenzene	ND	0.50	ug/L
Methyl tert-butyl ether	ND	5.0	ug/L
Toluene	**0.29 J,B**	**0.50**	**ug/L**
Xylenes (total)	ND	0.50	ug/L

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
a,a,a-Trifluorotoluene (TFT)	98	(82 - 112)

TE(S):

J Estimated result. Result is less than RL.

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

1C

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJ MP-A

GC Volatiles

Lot-Sample #...: D8L090209-007	Work Order #...: CP5K8101	Matrix.........: WG
Date Sampled...: 12/04/98 13:50	Date Received..: 12/09/98	
Prep Date......: 12/11/98	Analysis Date..: 12/11/98	
Prep Batch #...: 8346112	Analysis Time..: 20:13	
Dilution Factor: 1		
	Method.........: CFR136A 602	

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Benzene	**0.76**	**0.50**	**ug/L**
Chlorobenzene	ND	0.50	ug/L
1,2-Dichlorobenzene	ND	0.50	ug/L
1,3-Dichlorobenzene	ND	0.50	ug/L
1,4-Dichlorobenzene	ND	0.50	ug/L
Ethylbenzene	ND	0.50	ug/L
Methyl tert-butyl ether	**1.5 J**	**5.0**	**ug/L**
Toluene	ND	0.50	ug/L
Xylenes (total)	ND	0.50	ug/L

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
a,a,a-Trifluorotoluene (TFT)	92	(82 - 112)

NOTE(S):

J Estimated result. Result is less than RL.

1C

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJ MP-A

GC Volatiles

Lot-Sample #...:	D8L090209-007	Work Order #...:	CP5K8102	Matrix.........:	WG
Date Sampled...:	12/04/98 13:50	Date Received..:	12/09/98		
Prep Date......:	12/11/98	Analysis Date..:	12/11/98		
Prep Batch #...:	8346112	Analysis Time..:	20:13		
Dilution Factor:	1				
		Method.........:	CFR136A 602		

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Benzene	**0.66**	**0.50**	**ug/L**
Chlorobenzene	ND	0.50	ug/L
1,2-Dichlorobenzene	ND	0.50	ug/L
1,3-Dichlorobenzene	ND	0.50	ug/L
1,4-Dichlorobenzene	ND	0.50	ug/L
Ethylbenzene	ND	0.50	ug/L
Methyl tert-butyl ether	**1.2 J**	**5.0**	**ug/L**
Toluene	ND	0.50	ug/L
Xylenes (total)	ND	0.50	ug/L

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
a,a,a-Trifluorotoluene (TFT)	95	(82 - 112)

NOTE(S):

J Estimated result. Result is less than RL.

2C

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJ MP-B

GC Volatiles

Lot-Sample #...: D8L090209-008 Work Order #...: CP5K9101 Matrix..........: WG
Date Sampled...: 12/03/98 10:10 Date Received..: 12/09/98
Prep Date......: 12/11/98 Analysis Date..: 12/11/98
Prep Batch #...: 8346112 Analysis Time..: 20:49
Dilution Factor: 100

Method.........: CFR136A 602

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Benzene	980	50	ug/L
Chlorobenzene	ND	50	ug/L
1,2-Dichlorobenzene	ND	50	ug/L
1,3-Dichlorobenzene	ND	50	ug/L
1,4-Dichlorobenzene	ND	50	ug/L
Ethylbenzene	440	50	ug/L
Methyl tert-butyl ether	ND	500	ug/L
Toluene	2800 B	50	ug/L
Xylenes (total)	1800	50	ug/L

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
a,a,a-Trifluorotoluene (TFT)	95	(82 - 112)

NOTE(S):

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

1C

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJ MP-B

GC Volatiles

Lot-Sample #...:	D8L090209-008	Work Order #...:	CP5K9105	Matrix.........:	WG
Date Sampled...:	12/03/98 10:10	Date Received..:	12/09/98		
Prep Date......:	12/11/98	Analysis Date..:	12/11/98		
Prep Batch #...:	8346112	Analysis Time..:	20:49		
Dilution Factor:	100				
		Method.........:	CFR136A 602		

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Benzene	**940**	**50**	**ug/L**
Chlorobenzene	ND	50	ug/L
1,2-Dichlorobenzene	ND	50	ug/L
1,3-Dichlorobenzene	ND	50	ug/L
1,4-Dichlorobenzene	ND	50	ug/L
Ethylbenzene	**450**	**50**	**ug/L**
Methyl tert-butyl ether	ND	500	ug/L
Toluene	**2900 B**	**50**	**ug/L**
Xylenes (total)	**1800**	**50**	**ug/L**

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
a,a,a-Trifluorotoluene (TFT)	92	(82 - 112)

TE(S):

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

2C

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJ SW-1

GC Volatiles

Lot-Sample #...: D8L090209-009 Work Order #...: CP5KA101 Matrix.........: WG
Date Sampled...: 12/04/98 11:30 Date Received..: 12/09/98
Prep Date......: 12/11/98 Analysis Date..: 12/11/98
Prep Batch #...: 8346112 Analysis Time..: 22:37
Dilution Factor: 1

Method.........: CFR136A 602

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Benzene	ND	0.50	ug/L
Chlorobenzene	ND	0.50	ug/L
1,2-Dichlorobenzene	ND	0.50	ug/L
1,3-Dichlorobenzene	ND	0.50	ug/L
1,4-Dichlorobenzene	ND	0.50	ug/L
Ethylbenzene	ND	0.50	ug/L
Methyl tert-butyl ether	ND	5.0	ug/L
Toluene	ND	0.50	ug/L
Xylenes (total)	ND	0.50	ug/L

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
a,a,a-Trifluorotoluene (TFT)	94	(82 - 112)

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJ SW-2

GC Volatiles

Lot-Sample #...:	D8L090209-010	Work Order #...:	CP5KC101
Date Sampled...:	12/04/98 10:30	Date Received..:	12/09/98
Prep Date......:	12/11/98	Analysis Date..:	12/12/98
Prep Batch #...:	8346112	Analysis Time..:	00:59
Dilution Factor:	1	Method.........:	CFR136A 602

Matrix.........: WG

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Benzene	ND	0.50	ug/L
Chlorobenzene	ND	0.50	ug/L
1,2-Dichlorobenzene	ND	0.50	ug/L
1,3-Dichlorobenzene	ND	0.50	ug/L
1,4-Dichlorobenzene	ND	0.50	ug/L
Ethylbenzene	ND	0.50	ug/L
Methyl tert-butyl ether	ND	5.0	ug/L
Toluene	ND	0.50	ug/L
Xylenes (total)	ND	0.50	ug/L

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
a,a,a-Trifluorotoluene (TFT)	92	(82 - 112)

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: TRIP BLANK

GC Volatiles

Lot-Sample #...:	D8L090209-011	Work Order #...:	CP5KM101	Matrix..........:	WG
Date Sampled...:	12/04/98	Date Received..:	12/09/98		
Prep Date.......:	12/11/98	Analysis Date..:	12/12/98		
Prep Batch #...:	8346112	Analysis Time..:	01:35		
Dilution Factor:	1				
		Method..........:	CFR136A 602		

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Benzene	ND	0.50	ug/L
Chlorobenzene	ND	0.50	ug/L
1,2-Dichlorobenzene	ND	0.50	ug/L
1,3-Dichlorobenzene	ND	0.50	ug/L
1,4-Dichlorobenzene	ND	0.50	ug/L
Ethylbenzene	ND	0.50	ug/L
Methyl tert-butyl ether	ND	5.0	ug/L
Toluene	ND	0.50	ug/L
Xylenes (total)	ND	0.50	ug/L

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
a,a,a-Trifluorotoluene (TFT)	91	(82 - 112)

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJ MW-5

HPLC

Lot-Sample #...:	D8L090209-003	Work Order #...:	CP5K2104	Matrix.........:	WG
Date Sampled...:	12/03/98 11:30	Date Received..:	12/09/98		
Prep Date......:	12/10/98	Analysis Date..:	01/06/99		
Prep Batch #...:	9018166	Analysis Time..:	21:02		
Dilution Factor:	1				
		Method.........:	SW846 8310		

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Acenaphthene	ND	1.0	ug/L
Acenaphthylene	ND	1.0	ug/L
Anthracene	ND	0.10	ug/L
Benzo(a)anthracene	ND	0.13	ug/L
Benzo(a)pyrene	ND	0.23	ug/L
Benzo(b)fluoranthene	ND	0.18	ug/L
Benzo(ghi)perylene	ND	0.20	ug/L
Benzo(k)fluoranthene	ND	0.17	ug/L
Chrysene	ND	0.20	ug/L
Dibenzo(a,h)anthracene	ND	0.30	ug/L
Fluoranthene	ND	0.20	ug/L
Fluorene	ND	0.20	ug/L
Indeno(1,2,3-cd)pyrene	ND	0.43	ug/L
Naphthalene	ND	1.0	ug/L
Phenanthrene	ND	0.20	ug/L
Pyrene	ND	0.20	ug/L

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Terphenyl-d14	80	(25 - 157)

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJ MW-2

GC Volatiles

Lot-Sample #...:	D8L090209-001	Work Order #...:	CP5JV102	Matrix..........:	WG
Date Sampled...:	12/03/98 12:10	Date Received..:	12/09/98		
Prep Date......:	12/15/98	Analysis Date..:	12/15/98		
Prep Batch #...:	8351256	Analysis Time..:	13:14		
Dilution Factor:	1				
		Method.........:	EPA-9 RSK-175		

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Methane	3.4 B	0.50	ug/L

NOTE(S):

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJ MW-4

GC Volatiles

Lot-Sample #...:	D8L090209-002	Work Order #...:	CP5JX102	Matrix.........:	WG
Date Sampled...:	12/03/98 09:30	Date Received..:	12/09/98		
Prep Date......:	12/15/98	Analysis Date..:	12/15/98		
Prep Batch #...:	8351256	Analysis Time..:	13:20		
Dilution Factor:	1				
		Method.........:	EPA-9 RSK-175		

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Methane	410 B,E	0.50	ug/L

NOTE(S):

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

E Estimated result. Result concentration exceeds the calibration range.

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJ MW-4

GC Volatiles

Lot-Sample #...:	D8L090209-002	Work Order #...:	CP5JX202	Matrix.........:	WG
Date Sampled...:	12/03/98 09:30	Date Received..:	12/09/98		
Prep Date......:	12/15/98	Analysis Date..:	12/15/98		
Prep Batch #...:	8351284	Analysis Time..:	17:22		
Dilution Factor:	50				
		Method.........:	EPA-9 RSK-175		

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Methane	1700 B,D	25	ug/L

NOTE(S):

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

D Result was obtained from the analysis of a dilution.

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJ MW-5

GC Volatiles

Lot-Sample #...:	D8L090209-003	Work Order #...:	CP5K2105	Matrix.........:	WG
Date Sampled...:	12/03/98 11:30	Date Received..:	12/09/98		
Prep Date......:	12/15/98	Analysis Date..:	12/15/98		
Prep Batch #...:	8351256	Analysis Time..:	13:31		
Dilution Factor:	1				
		Method.........:	EPA-9 RSK-175		

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Methane	0.31 J,B	0.50	ug/L

NOTE(S):

J Estimated result. Result is less than RL.

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJ MP-B

GC Volatiles

Lot-Sample #...:	D8L090209-008	Work Order #...:	CP5K9104	Matrix.........:	WG
Date Sampled...:	12/03/98 10:10	Date Received..:	12/09/98		
Prep Date......:	12/15/98	Analysis Date..:	12/15/98		
Prep Batch #...:	8351256	Analysis Time..:	13:37		
Dilution Factor:	1				
		Method.........:	EPA-9 RSK-175		

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Methane	340 B,E	0.50	ug/L

NOTE(S):

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

E Estimated result. Result concentration exceeds the calibration range.

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJ MP-B

GC Volatiles

Lot-Sample #...:	D8L090209-008	Work Order #...:	CP5K9204	Matrix.........:	WG
Date Sampled...:	12/03/98 10:10	Date Received..:	12/09/98		
Prep Date......:	12/15/98	Analysis Date..:	12/15/98		
Prep Batch #...:	8351284	Analysis Time..:	17:16		
Dilution Factor:	20				
		Method.........:	EPA-9 RSK-175		

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Methane	1200 B,D	10	ug/L

NOTE(S):

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

D Result was obtained from the analysis of a dilution.

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: TRIP BLANK

GC Volatiles

Lot-Sample #...:	D8L090209-011	Work Order #...:	CP5KM102	Matrix..........:	WG
Date Sampled...:	12/04/98	Date Received..:	12/09/98		
Prep Date......:	12/15/98	Analysis Date..:	12/15/98		
Prep Batch #...:	8351256	Analysis Time..:	13:50		
Dilution Factor:	1				
		Method.........:	EPA-9 RSK-175		

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Methane	0.18 J,B	0.50	ug/L

NOTE(S):

J Estimated result. Result is less than RL.

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

Laboratory Non-Conformance Memo (NCM)

Quanterra Environmental Services

NCM Log Number 15898

4187

D/Client	Sample Numbers	NCM Initiated by/Date	Project Manager
18166 D8L090209-003		DBR 1/18/99	E. LaRiviere

Analyst/Team

Tests 8310 PAH

Analytical Area (check appropriate box)

- [ ] Sample control
- [ ] Organic preparation
- [ ] Inorganic preparation
- [ ] GC
- [X] HPLC
- [ ] GC/MS
- [ ] Wet chemistry
- [ ] Metals
- [ ] Reporting
- [ ] Data review
- [ ] Radiochemistry
- [ ] ______

Non-Conformance (check appropriate box) To be completed by analyst

Holding Time Violation (exceeded by ________ days)

Category I: Laboratory Independent

- [ ] 1. Holding time expired in transit
- [ ] 2. Sample received > 48 hours or 1/2 holding time has expired
- [ ] 3. Test added by client after expiration

Category II: Laboratory Dependent

- [ ] 4. Instrument failure
- [ ] 5. Analyst error
- [ ] 6. Log-in error
- [ ] Miscommunication
- [ ] 8. Other (explanation required)

Category III: Analysis Reruns (QA/QC)

- [ ] 9. Surrogates
- [ ] 10. Internal standards
- [ ] 11. Spike recoveries
- [ ] 12. Blank contamination

Category IV: Analysis Reruns (Confirmation)

- [ ] 13. Second column
- [ ] 14. Contamination check
- [ ] 15. Confirmation of matrix effects
- [ ] 16. Other (explanation required) ______

Quality Assurance/Quality Control

- [X] 17. QC data reported outside of controls
- [ ] 18. Incorrect procedure used
- [ ] 19. SOP intentionally modified with QA and tech approval
- [ ] 20. Invalid instrument calibration
- [ ] 21. Received insuffient sample for proper analysis

Incorrect or Incomplete Client Deliverable

- [ ] 22. Hardcopy deliverable error
- [ ] 23. Electronic deliverable error

Reported Detection Limits Elevated Due to:

- [ ] 24. Sample matrix: Does not include high analyte content
- [ ] 25. Insufficient sample volume
- [ ] 26. Other (explanation required)

Miscellaneous

- [ ] 27. Instrument Tag-out
- [ ] 28. Other (explanation required) ______

Notification (check appropriate box) To be completed by project manager

- [ ] Required
- [X] Not Required

ified by - Name	Date				
		[ ] In writing	[ ] By telephone	[ ] By facsimile	[ ] Other (explain) ______
Client's name and response		[ ] Process "as is"	[ ] On hold until ______	[ ] Re-sample	[ ] Other (explain) ______

Project manager signature Ellen LaRiviere Date 1/15/99

Laboratory Non-Conformance Memo (NCM)

Quanterra Environmental Services

NCM Log Number 15898

.-4187

Corrective Action (To be completed and reviewed by all associates involved)

Problem Description/Root Cause: dibenzo(a,h)anthracene has high recoveries in LCS (117% max is 103) and LCSD (120% max is 103%)

Author's initials and date: DOK 1/18/99

Corrective Actions (Short Term): there are no hits for dibenzo(a,h)anthracene in the sample

Author's initials and date: DOK 1/18/99

Corrective Actions to Prevent Reoccurence (Long Term)

Corrective Action approved by (Supervisor/Group Leader) and date

'itional Comments

Corrective Action to be completed by (if other than Supervisor/Group Leader)

Date Corrective Action is to be completed

Quality Assurance Review (To be completed by a QA associate)

Log ID ☐ Anomaly ☒ Deficiency ☐ Notified Ops/Sys Manager (Initials)

☐ Further action required

☐ Further action assigned to

QA signature: [signature] Date 1/19/99

Corrective Action Verification (To be completed by a QA associate)

☐ Verification not required or requested ☐ Verified/CA completed on ______ by ______

☐ Cannot verifiy (specify reason)

'ified by Date

Nonconformance Memo Closure

QA signature: [signature] Date 1/19/99

The office of Quality Assurance maintains a copy of this NCM indicating its final status.

TI ~~24044~~ 1017

Chain of Custody Record

Quanterra

QUA-4124 0797

Client	Parsons ES
Address	1700 Broadway Suite 900
City	Denver
State	CO
Zip Code	80290
Project Name	AFCEE RBCA
Contract/Purchase Order/Quote No.	
Project Manager	John Hicks
Telephone Number (Area Code)/Fax Number	303-831-8100
Site Contact	Tom Dragoo
Lab Contact	Ellen
Carrier/Waybill Number	
Date	11/8/98
Lab Number	D8L090209
Chain of Custody Number	20256
Page	1 of 1

Analysis (Attach list if more space is needed)

Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Matrix: Aqueous	Sed.	Soil		Containers & Preservatives: Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/NaOH	602 VOC	625 SVOC	8310 SVOC	602 (MS)	602 (MSD)	Special Instructions/ Conditions of Receipt
98SJ MW-2	12/3/98	1210	X										X					
98SJ MW-4	12/3/98	0930	X										X					
98SJ MW-5	12/3/98	1130	X										X	X	X			
98SJ MW-6	12/2/98	0800	X										X					
98SJ MW-7	12/4/98	1310	X										X					
98SJ MW-8	12/4/98	1330	X										X					
98SJ MP-A	12/4/98	1350	X										X					
98SJ MP-B	12/3/98	1010	X										X			X	X	
98SJ SW-1	12/4/98	1130	X										X			X	X	
98SJ SW-2	12/4/98	1030	X										X					
TRIP																		
TEMP BLANK																		

Possible Hazard Identification
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☒ Unknown

Sample Disposal
☐ Return To Client ☐ Disposal By Lab ☒ Archive For 30 Months (A fee may be assessed if samples are retained longer than 3 months)

Turn Around Time Required
☐ 24 Hours ☒ 48 Hours ☐ 7 Days ☐ 14 Days ☐ 21 Days ☐ Other ____

QC Requirements (Specify)

	Date	Time		Date	Time
1. Relinquished By: [signature]	12/8/98	1600	1. Received By: [signature]	12/9/98	0900
2. Relinquished By			2. Received By		
3. Relinquished By			3. Received By		

Comments
7
6

DISTRIBUTION: WHITE - Stays with the Sample; CANARY - Returned to Client with Report; PINK - Field Copy

Chain of Custody Record

QUA-4124 0797

Quanterra

Found Run + L090209 per Tom in Austin

(12)

Client	Project Manager	Date	Chain of Custody Number
Parsons Engineering Science Inc	John Hicks	12/8/98	20258

Address	Telephone Number (Area Code)/Fax Number	Lab Number	Page
1700 Broadway Suite 900	303-831-8100 fax-8208		1 of 1

City	State	Zip Code	Site Contact	Lab Contact
Denver	CO	80290	Tom Dragoo	Ellen

Project Name: AFCEE Risk-Based Investigation

Carrier/Waybill Number:

Contract/Purchase Order/Quote No.: 731854.05000

Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Matrix: Aqueous	Matrix: Sed.	Matrix: Soil		Containers & Preservatives: Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/NaOH		Analysis: Methane RSK-175	RSK175 (MS)	RSK175 (MSD)	Special Instructions/ Conditions of Receipt
98SJ MW-2	12/3/98	1210	X							X				X			
98SJ MW-4	12/3/98	0930	X							X				X	X	X	
98SJ MW-5	12/3/98	1130	X							X				X			
98SJ MP-B	12/3/98	1010	X							X				X			
TEMP BLANK																	
TRIP BLANK																	

Possible Hazard Identification
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☒ Unknown

Sample Disposal
☐ Return To Client ☐ Disposal By Lab ☒ Archive For 3 Months (A fee may be assessed if samples are retained longer than 3 months)

Turn Around Time Required
☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☐ 14 Days ☐ 21 Days ☐ Other

QC Requirements (Specify): MS/MSD on MW-4

Relinquished By	Date	Time	Received By	Date	Time
1. Relinquished By [signature]	12/8/98	1600	1. Received By		
2. Relinquished By			2. Received By		
3. Relinquished By			3. Received By		

Comments

DISTRIBUTION: ...TE - Stays with the Sample; CANARY - Returned to Client with Report; PINK - Field Copy

SAMPLE CHECKLIST

Lot #: D8L090208 Date/Time Received: 12/9/98 @ 0900

Company Name & Sampling Site: Parsons

*Cooler #(s):

Temperatures: 5.2

Unpacking & Labeling Check Points:

N/A	Yes	No	Check Point	Initials
	☑	☐	1. Radiation checked, record if reading > 0.5 mR/hr. (mR/hr)	NB
	☑	☐	2. Cooler seals intact.	
	☑	☐	3. Chain of custody present.	
	☐	☑	4. Bottles broken and/or are leaking, comment if yes.	
			PHOTOGRAPH BROKEN BOTTLES	
	☑	☐	5. Containers labeled, comment if no.	
	☐	☑	6. pH of all samples checked and meet requirements, note exceptions.	
	☑	☐	7. Chain of custody includes "received by" and "relinquished" by signatures, dates, and times.	
	☐	☑	8. Receipt date(s) > 48 hours past the collection date(s)? If yes, notify PA/PM.	
	☐	☑	9. Chain of custody agrees with bottle count, comment if no.	
	☑	☐	10. Chain of custody agrees with labels, comment if no. SW-1 1 VOA short for MS/MSD	
	☑	☐	11. VOA samples filled completely, comment if no.	
☐		☐	12. VOA bottles preserved, check for labels.	
	☐	☑	13. Did samples require preservation with sodium thiosulfate?	
☐	☐	☑	14. If yes to #12, did the samples contain residual chlorine?	
☐	☐	☑	15. Sediment present in "D," dissolved, bottles.	
	☐	☑	16. Are analyses with short holding times requested?	
☐	☐	☑	17. Is extra sample volume provided for MS, MSD or matrix duplicates?	
	☐	☑	18. Multiphase samples present? If yes, comment below.	
	☐	☑	19. Any subsampling for volatiles? If yes, list samples.	
			PHOTOGRAPH MULTIPHASE SAMPLES	
☐	☐	☐	20. Clear picture taken, labeled, and stapled to project folder.	
☐	☐	☐	21. Subcontract COC signed and sent with samples to bottle prep?	
	☐	☐	22. Was sample labeling double checked?	

Comments: Include action taken to resolve discrepancies/problems. Include a hard copy of e-mail or use extra paper if more space is needed. Trip Blk tests not on COC but added

Initials:

Revision 4 6/25/98

G:\FORMS\SAMPLE RECEIVING\SAMPCHKL.DOC

Quanterra Incorporated
4955 Yarrow Street
Arvada, Colorado 80002

303 421-6611 Telephone
303 431-7171 Fax

ANALYTICAL REPORT

Seymour Johnson AFB
Lot #: D8L040119

John Hicks

Parsons Engineering Services

QUANTERRA INCORPORATED

Ellen La Riviere

Ellen La Riviere
Project Manager

January 21, 1999

Table Of Contents

Standard Deliverables With Supporting Documentation

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Project Narrative
(D8L040119)

GC/MS Volatiles

Due to the concentration of target compounds present, samples D8L040119-002 and –004 were extracted as medium level soils. Due to the extraction procedure, bromomethane and dichlorodifluoromethane were recovered below the lower control limits in the LCS/LCSD associated with the samples. The client was contacted on December 21, 1998. Because these were not compounds of concern for the site, no further action was required.

GC/MS Semi-Volatiles

The relative percent difference for the LCS/LCSD associated with the soil samples exceeded the control limit for 4,6-dinitro-2-methylphenol and 2,4-dinitrophenol. The individual recoveries for these compounds were within acceptable limits. Because the MS/MSD was within acceptable limits, the laboratory took no further action.

Several compounds exceeded the control limits on the continuing calibration associated with the Method 8270 QC batch 8342215. Because this would indicate a high bias to the data, and the effected compounds were not detected in the samples, the data was not adversely effected and the laboratory took no further action.

EXECUTIVE SUMMARY - Detection Highlights

D8L040119

PARAMETER	RESULT	REPORTING LIMIT	UNITS	ANALYTICAL METHOD
98SJSB1-4 12/03/98 09:30 001				
2-Methylnaphthalene	31	7.5	mg/kg	SW846 8270B
Naphthalene	31	7.5	mg/kg	SW846 8270B
Percent Moisture	6.6	0.10	%	MCAWW 160.3 MOD
98SJSB1-2.5 12/03/98 09:30 002				
n-Butylbenzene	5.8	1.4	mg/kg	SW846 8260A
sec-Butylbenzene	2.6	2.0	mg/kg	SW846 8260A
Ethylbenzene	3.6	0.84	mg/kg	SW846 8260A
Isopropylbenzene	2.0 F	2.2	mg/kg	SW846 8260A
Methylene chloride	0.42 F	1.4	mg/kg	SW846 8260A
Naphthalene	7.1	1.4	mg/kg	SW846 8260A
n-Propylbenzene	3.8	0.56	mg/kg	SW846 8260A
Toluene	2.7	1.4	mg/kg	SW846 8260A
1,2,4-Trimethylbenzene	21	2.0	mg/kg	SW846 8260A
1,3,5-Trimethylbenzene	13	0.84	mg/kg	SW846 8260A
o-Xylene	6.1	1.4	mg/kg	SW846 8260A
m-Xylene & p-Xylene	14	2.5	mg/kg	SW846 8260A
Percent Moisture	11.1	0.10	%	MCAWW 160.3 MOD
98SJSB2-3 12/02/98 12:00 003				
2-Methylnaphthalene	8.9	3.2	mg/kg	SW846 8270B
Naphthalene	7.2	3.2	mg/kg	SW846 8270B
Percent Moisture	13.4	0.10	%	MCAWW 160.3 MOD
98SJSB2-4 12/02/98 12:00 004				
n-Butylbenzene	13	5.7	mg/kg	SW846 8260A
sec-Butylbenzene	6.8 F	8.0	mg/kg	SW846 8260A
Ethylbenzene	6.4	3.4	mg/kg	SW846 8260A
Isopropylbenzene	3.5 F	9.2	mg/kg	SW846 8260A
Naphthalene	20	5.7	mg/kg	SW846 8260A
n-Propylbenzene	6.2	2.3	mg/kg	SW846 8260A
Toluene	2.1 F	5.7	mg/kg	SW846 8260A
1,2,4-Trimethylbenzene	52	8.0	mg/kg	SW846 8260A
1,3,5-Trimethylbenzene	25	3.4	mg/kg	SW846 8260A
o-Xylene	6.1	5.7	mg/kg	SW846 8260A
m-Xylene & p-Xylene	25	3.4	mg/kg	SW846 8260A
Percent Moisture	13.0	0.10	%	MCAWW 160.3 MOD

(Continued on next page)

EXECUTIVE SUMMARY - Detection Highlights

D8L040119

PARAMETER	RESULT	REPORTING LIMIT	UNITS	ANALYTICAL METHOD
98SJSB3-4.5 12/03/98 10:30 005				
Percent Moisture	8.7	0.10	%	MCAWW 160.3 MOD
98SJSB3-5.5 12/03/98 10:30 006				
n-Butylbenzene	1.5	0.28	mg/kg	SW846 8260A
sec-Butylbenzene	0.67	0.39	mg/kg	SW846 8260A
Ethylbenzene	0.97	0.17	mg/kg	SW846 8260A
Isopropylbenzene	0.51	0.44	mg/kg	SW846 8260A
Naphthalene	1.3	0.28	mg/kg	SW846 8260A
n-Propylbenzene	1.0	0.11	mg/kg	SW846 8260A
Toluene	0.13 F	0.28	mg/kg	SW846 8260A
1,2,4-Trimethylbenzene	5.0	0.39	mg/kg	SW846 8260A
1,3,5-Trimethylbenzene	2.3	0.17	mg/kg	SW846 8260A
o-Xylene	1.4	0.28	mg/kg	SW846 8260A
m-Xylene & p-Xylene	3.4	0.17	mg/kg	SW846 8260A
Percent Moisture	10.1	0.10	%	MCAWW 160.3 MOD
98SJSB4-5 12/01/98 16:00 007				
Total Organic Carbon	590 F	2000	mg/kg	SW846 9060
98SJSB5-3 12/02/98 16:30 008				
Total Organic Carbon	1980 F	2000	mg/kg	SW846 9060
98SJMW-5 12/03/98 11:30 010				
Nitrate	0.41 F	1.0	mg/L	SW846 9056
TRIP BLANK 12/03/98 013				
Methylene chloride	9.4	5.0	ug/L	SW846 8260A

ANALYTICAL METHODS SUMMARY

D8L040119

PARAMETER	ANALYTICAL METHOD
Nitrate as N	SW846 9056
Percent Moisture	MCAWW 160.3 MOD
Semivolatile Organic Compounds by GC/MS	SW846 8270B
Total Organic Carbon	SW846 9060
Volatile Organics by GC/MS	SW846 8260A

References:

MCAWW "Methods for Chemical Analysis of Water and Wastes", EPA-600/4-79-020, March 1983 and subsequent revisions.

SW846 "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 and its updates.

METHOD / ANALYST SUMMARY

D8L040119

ANALYTICAL METHOD	ANALYST	ANALYST ID
MCAWW 160.3 MOD	Andrea Sporleder	001971
SW846 8260A	Mike G. Hoffman	001880
SW846 8270B	Timothy J. Lavey	001903
SW846 9056	Patty Jungk	002008
SW846 9060	Ewa Kudla	001167

References:

MCAWW "Methods for Chemical Analysis of Water and Wastes", EPA-600/4-79-020, March 1983 and subsequent revisions.

SW846 "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 and its updates.

SAMPLE SUMMARY

D8L040119

WO #	SAMPLE#	CLIENT SAMPLE ID	DATE	TIME
CP0H8	001	98SJSB1-4	12/03/98	09:30
CP0HC	002	98SJSB1-2.5	12/03/98	09:30
CP0HE	003	98SJSB2-3	12/02/98	12:00
CP0HF	004	98SJSB2-4	12/02/98	12:00
CP0HG	005	98SJSB3-4.5	12/03/98	10:30
CP0HK	006	98SJSB3-5.5	12/03/98	10:30
CP0HQ	007	98SJSB4-5	12/01/98	16:00
CP0J6	008	98SJSB5-3	12/02/98	16:30
CP0J8	009	98SJMP-B	12/03/98	10:10
CP0JN	010	98SJMW-5	12/03/98	11:30
CP0K1	011	98SJMW-4	12/03/98	09:30
CP0K4	012	98SJMW-2	12/03/98	12:10
CP2MR	013	TRIP BLANK	12/03/98	

NOTE(S):

- The analytical results of the samples listed above are presented on the following pages.
- All calculations are performed before rounding to avoid round-off errors in calculated results.
- Results noted as "ND" were not detected at or above the stated limit.
- This report must not be reproduced, except in full, without the written approval of the laboratory.
- Results for the following parameters are never reported on a dry weight basis: color, corrosivity, density, flashpoint, ignitability, layers, odor, int filter test, pH, porosity pressure, reactivity, redox potential, specific gravity, spot tests, solids, solubility, temperature, viscosity, and weight.

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJSB1-2.5

GC/MS Volatiles

L040119-002 Work Order #...: CP0HC101
/03/98 09:30 Date Received..: 12/04/98 Matrix.........: SO
/14/98 Analysis Date..: 12/16/98
.9272 Analysis Time..: 17:56

Method.........: SW846 8260A

	RESULT	REPORTING LIMIT	UNITS
	ND	0.56	mg/kg
	ND	0.56	mg/kg
	ND	0.56	mg/kg
	ND	1.1	mg/kg
	ND	1.7	mg/kg
	ND	1.4	mg/kg
	5.8	**1.4**	**mg/kg**
	2.6	**2.0**	**mg/kg**
	ND	2.0	mg/kg
	ND	2.8	mg/kg
	ND	0.56	mg/kg
	ND	0.84	mg/kg
	ND	1.4	mg/kg
	ND	0.56	mg/kg
	ND	0.84	mg/kg
	ND	2.0	mg/kg
	ND	0.56	mg/kg
	ND	0.84	mg/kg
	ND	2.8	mg/kg
	ND	0.56	mg/kg
	ND	1.7	mg/kg
	ND	0.56	mg/kg
	ND	1.4	mg/kg
	ND	0.56	mg/kg
	ND	0.84	mg/kg
	ND	1.7	mg/kg
	ND	1.7	mg/kg
	ND	0.84	mg/kg
	ND	0.56	mg/kg
	ND	0.56	mg/kg
	ND	5.6	mg/kg
	ND	1.4	mg/kg
	ND	1.4	mg/kg
	ND	1.4	mg/kg
	3.6	**0.84**	**mg/kg**
	ND	1.1	mg/kg
	ND	1.4	mg/kg
	2.0 F	**2.2**	**mg/kg**

(Continued on next page)

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJSB1-2.5

GC/MS Volatiles

Lot-Sample #...: D8L040119-002 Work Order #...: CP0HC101 Matrix.........: SO

PARAMETER	RESULT	REPORTING LIMIT	UNITS
p-Isopropyltoluene	ND	1.7	mg/kg
Methylene chloride	**0.42 F**	**1.4**	**mg/kg**
Naphthalene	**7.1**	**1.4**	**mg/kg**
n-Propylbenzene	**3.8**	**0.56**	**mg/kg**
Styrene	ND	0.56	mg/kg
1,1,1,2-Tetrachloroethane	ND	0.84	mg/kg
1,1,2,2-Tetrachloroethane	ND	0.56	mg/kg
Tetrachloroethene	ND	2.0	mg/kg
Toluene	**2.7**	**1.4**	**mg/kg**
1,2,3-Trichlorobenzene	ND	0.56	mg/kg
1,2,4-Trichlorobenzene	ND	0.56	mg/kg
1,1,1-Trichloroethane	ND	1.1	mg/kg
1,1,2-Trichloroethane	ND	1.4	mg/kg
Trichloroethene	ND	2.8	mg/kg
1,2,3-Trichloropropane	ND	5.6	mg/kg
1,2,4-Trimethylbenzene	**21**	**2.0**	**mg/kg**
1,3,5-Trimethylbenzene	**13**	**0.84**	**mg/kg**
Vinyl chloride	ND	2.5	mg/kg
[illegible]-Xylene	**6.1**	**1.4**	**mg/kg**
[illegible]-Xylene & p-Xylene	**14**	**2.5**	**mg/kg**
1,2-Dibromo-3-chloropropane (DBCP)	ND	2.8	mg/kg
1,2-Dibromoethane (EDB)	ND	0.84	mg/kg

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
1,2-Dichloroethane-d4	87 DIL	(52 - 149)
4-Bromofluorobenzene	123 DIL	(65 - 135)
Toluene-d8	116 DIL	(65 - 135)
Dibromofluoromethane	86 DIL	(65 - 135)

NOTE(S):

DIL The concentration is estimated or not reported due to dilution or the presence of interfering analytes.

Results and reporting limits have been adjusted for dry weight.

Elevated reporting limits. The reporting limits are elevated due to matrix interference.

F The analyte was identified but the value was below the RL and above the MDL.

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJSB2-4

GC/MS Volatiles

Lot-Sample #...:	D8L040119-004	Work Order #...:	CP0HF101	Matrix.........:	SO
Date Sampled...:	12/02/98 12:00	Date Received..:	12/04/98		
Prep Date......:	12/14/98	Analysis Date..:	12/16/98		
Prep Batch #...:	9019272	Analysis Time..:	18:48		
Dilution Factor:	20				
% Moisture.....:	13	Method.........:	SW846 8260A		

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Benzene	ND	2.3	mg/kg
Bromobenzene	ND	2.3	mg/kg
Bromochloromethane	ND	2.3	mg/kg
Bromodichloromethane	ND	4.6	mg/kg
Bromoform	ND	6.9	mg/kg
Bromomethane	ND	5.7	mg/kg
n-Butylbenzene	**13**	**5.7**	**mg/kg**
sec-Butylbenzene	**6.8 F**	**8.0**	**mg/kg**
tert-Butylbenzene	ND	8.0	mg/kg
Carbon tetrachloride	ND	11	mg/kg
Chlorobenzene	ND	2.3	mg/kg
Chlorodibromomethane	ND	3.4	mg/kg
Chloroethane	ND	5.7	mg/kg
Chloroform	ND	2.3	mg/kg
1-Chlorohexane	ND	3.4	mg/kg
Chloromethane	ND	8.0	mg/kg
2-Chlorotoluene	ND	2.3	mg/kg
4-Chlorotoluene	ND	3.4	mg/kg
Dibromomethane	ND	11	mg/kg
1,2-Dichlorobenzene	ND	2.3	mg/kg
1,3-Dichlorobenzene	ND	6.9	mg/kg
1,4-Dichlorobenzene	ND	2.3	mg/kg
Dichlorodifluoromethane	ND	5.7	mg/kg
1,1-Dichloroethane	ND	2.3	mg/kg
1,2-Dichloroethane	ND	3.4	mg/kg
1,1-Dichloroethene	ND	6.9	mg/kg
cis-1,2-Dichloroethene	ND	6.9	mg/kg
trans-1,2-Dichloroethene	ND	3.4	mg/kg
1,2-Dichloropropane	ND	2.3	mg/kg
1,3-Dichloropropane	ND	2.3	mg/kg
2,2-Dichloropropane	ND	23	mg/kg
1,1-Dichloropropene	ND	5.7	mg/kg
cis-1,3-Dichloropropene	ND	5.7	mg/kg
trans-1,3-Dichloropropene	ND	5.7	mg/kg
Ethylbenzene	**6.4**	**3.4**	**mg/kg**
Trichlorofluoromethane	ND	4.6	mg/kg
Hexachlorobutadiene	ND	5.7	mg/kg
Isopropylbenzene	**3.5 F**	**9.2**	**mg/kg**

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PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJSB2-4

GC/MS Volatiles

Lot-Sample #...: D8L040119-004 Work Order #...: CP0HF101 Matrix.........: SO

PARAMETER	RESULT	REPORTING LIMIT	UNITS
p-Isopropyltoluene	ND	6.9	mg/kg
Methylene chloride	ND	5.7	mg/kg
Naphthalene	**20**	**5.7**	**mg/kg**
n-Propylbenzene	**6.2**	**2.3**	**mg/kg**
Styrene	ND	2.3	mg/kg
1,1,1,2-Tetrachloroethane	ND	3.4	mg/kg
1,1,2,2-Tetrachloroethane	ND	2.3	mg/kg
Tetrachloroethene	ND	8.0	mg/kg
Toluene	**2.1 F**	**5.7**	**mg/kg**
1,2,3-Trichlorobenzene	ND	2.3	mg/kg
1,2,4-Trichlorobenzene	ND	2.3	mg/kg
1,1,1-Trichloroethane	ND	4.6	mg/kg
1,1,2-Trichloroethane	ND	5.7	mg/kg
Trichloroethene	ND	11	mg/kg
1,2,3-Trichloropropane	ND	23	mg/kg
1,2,4-Trimethylbenzene	**52**	**8.0**	**mg/kg**
1,3,5-Trimethylbenzene	**25**	**3.4**	**mg/kg**
Vinyl chloride	ND	10	mg/kg
[illegible]-Xylene	**6.1**	**5.7**	**mg/kg**
[illegible]-Xylene & p-Xylene	**25**	**3.4**	**mg/kg**
1,2-Dibromo-3-chloropropane (DBCP)	ND	11	mg/kg
1,2-Dibromoethane (EDB)	ND	3.4	mg/kg

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
1,2-Dichloroethane-d4	0.0 DIL,NC	(52 - 149)
4-Bromofluorobenzene	0.0 DIL,NC	(65 - 135)
Toluene-d8	0.0 DIL,NC	(65 - 135)
Dibromofluoromethane	0.0 DIL,NC	(65 - 135)

NOTE(S):

DIL The concentration is estimated or not reported due to dilution or the presence of interfering analytes.

NC The recovery and/or RPD were not calculated.

Results and reporting limits have been adjusted for dry weight.

Elevated reporting limits. The reporting limits are elevated due to matrix interference.

F The analyte was identified but the value was below the RL and above the MDL.

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJSB3-5.5

GC/MS Volatiles

Lot-Sample #...: D8L040119-006 Work Order #...: CP0HK101 Matrix.........: SO
Date Sampled...: 12/03/98 10:30 Date Received..: 12/04/98
Prep Date.......: 12/14/98 Analysis Date..: 12/16/98
Prep Batch #...: 9019272 Analysis Time..: 20:45
Dilution Factor: 1
% Moisture.....: 10 Method.........: SW846 8260A

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Benzene	ND	0.11	mg/kg
Bromobenzene	ND	0.11	mg/kg
Bromochloromethane	ND	0.11	mg/kg
Bromodichloromethane	ND	0.22	mg/kg
Bromoform	ND	0.33	mg/kg
Bromomethane	ND	0.28	mg/kg
n-Butylbenzene	**1.5**	**0.28**	**mg/kg**
sec-Butylbenzene	**0.67**	**0.39**	**mg/kg**
tert-Butylbenzene	ND	0.39	mg/kg
Carbon tetrachloride	ND	0.56	mg/kg
Chlorobenzene	ND	0.11	mg/kg
Chlorodibromomethane	ND	0.17	mg/kg
Chloroethane	ND	0.28	mg/kg
Chloroform	ND	0.11	mg/kg
1-Chlorohexane	ND	0.17	mg/kg
Chloromethane	ND	0.39	mg/kg
2-Chlorotoluene	ND	0.11	mg/kg
4-Chlorotoluene	ND	0.17	mg/kg
Dibromomethane	ND	0.56	mg/kg
1,2-Dichlorobenzene	ND	0.11	mg/kg
1,3-Dichlorobenzene	ND	0.33	mg/kg
1,4-Dichlorobenzene	ND	0.11	mg/kg
Dichlorodifluoromethane	ND	0.28	mg/kg
1,1-Dichloroethane	ND	0.11	mg/kg
1,2-Dichloroethane	ND	0.17	mg/kg
1,1-Dichloroethene	ND	0.33	mg/kg
cis-1,2-Dichloroethene	ND	0.33	mg/kg
trans-1,2-Dichloroethene	ND	0.17	mg/kg
1,2-Dichloropropane	ND	0.11	mg/kg
1,3-Dichloropropane	ND	0.11	mg/kg
2,2-Dichloropropane	ND	1.1	mg/kg
1,1-Dichloropropene	ND	0.28	mg/kg
cis-1,3-Dichloropropene	ND	0.28	mg/kg
trans-1,3-Dichloropropene	ND	0.28	mg/kg
Ethylbenzene	**0.97**	**0.17**	**mg/kg**
Trichlorofluoromethane	ND	0.22	mg/kg
Hexachlorobutadiene	ND	0.28	mg/kg
Isopropylbenzene	**0.51**	**0.44**	**mg/kg**

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PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJSB3-5.5

GC/MS Volatiles

Lot-Sample #...: D8L040119-006 Work Order #...: CP0HK101 Matrix.........: SO

PARAMETER	RESULT	REPORTING LIMIT	UNITS
p-Isopropyltoluene	ND	0.33	mg/kg
Methylene chloride	ND	0.28	mg/kg
Naphthalene	**1.3**	**0.28**	**mg/kg**
n-Propylbenzene	**1.0**	**0.11**	**mg/kg**
Styrene	ND	0.11	mg/kg
1,1,1,2-Tetrachloroethane	ND	0.17	mg/kg
1,1,2,2-Tetrachloroethane	ND	0.11	mg/kg
Tetrachloroethene	ND	0.39	mg/kg
Toluene	**0.13 F**	**0.28**	**mg/kg**
1,2,3-Trichlorobenzene	ND	0.11	mg/kg
1,2,4-Trichlorobenzene	ND	0.11	mg/kg
1,1,1-Trichloroethane	ND	0.22	mg/kg
1,1,2-Trichloroethane	ND	0.28	mg/kg
Trichloroethene	ND	0.56	mg/kg
1,2,3-Trichloropropane	ND	1.1	mg/kg
1,2,4-Trimethylbenzene	**5.0**	**0.39**	**mg/kg**
1,3,5-Trimethylbenzene	**2.3**	**0.17**	**mg/kg**
Vinyl chloride	ND	0.50	mg/kg
o-Xylene	**1.4**	**0.28**	**mg/kg**
m-Xylene & p-Xylene	**3.4**	**0.17**	**mg/kg**
1,2-Dibromo-3-chloropropane (DBCP)	ND	0.56	mg/kg
1,2-Dibromoethane (EDB)	ND	0.17	mg/kg

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
1,2-Dichloroethane-d4	83	(52 - 149)
4-Bromofluorobenzene	127	(65 - 135)
Toluene-d8	96	(65 - 135)
Dibromofluoromethane	90	(65 - 135)

NOTE(S):

Results and reporting limits have been adjusted for dry weight.

F The analyte was identified but the value was below the RL and above the MDL.

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: TRIP_BLANK

GC/MS Volatiles

Lot-Sample #...: D8L040119-013 Work Order #...: CP2MR101 Matrix.........: WQ
Date Sampled...: 12/03/98 Date Received..: 12/04/98
Prep Date......: 12/17/98 Analysis Date..: 12/17/98
Prep Batch #...: 9014164 Analysis Time..: 17:53
Dilution Factor: 1

Method.........: SW846 8260A

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Benzene	ND	0.50	ug/L
Bromobenzene	ND	0.50	ug/L
Bromochloromethane	ND	0.50	ug/L
Bromodichloromethane	ND	0.80	ug/L
Bromoform	ND	1.2	ug/L
Bromomethane	ND	1.1	ug/L
n-Butylbenzene	ND	1.1	ug/L
sec-Butylbenzene	ND	1.3	ug/L
tert-Butylbenzene	ND	1.4	ug/L
Carbon tetrachloride	ND	2.1	ug/L
Chlorobenzene	ND	0.50	ug/L
Chlorodibromomethane	ND	0.50	ug/L
Chloroethane	ND	1.0	ug/L
Chloroform	ND	0.50	ug/L
1-Chlorohexane	ND	0.50	ug/L
Chloromethane	ND	1.3	ug/L
2-Chlorotoluene	ND	0.50	ug/L
4-Chlorotoluene	ND	0.60	ug/L
Dibromomethane	ND	2.4	ug/L
1,2-Dichlorobenzene	ND	0.50	ug/L
1,3-Dichlorobenzene	ND	1.2	ug/L
1,4-Dichlorobenzene	ND	0.50	ug/L
Dichlorodifluoromethane	ND	1.0	ug/L
1,1-Dichloroethane	ND	0.50	ug/L
1,2-Dichloroethane	ND	0.60	ug/L
1,1-Dichloroethene	ND	1.2	ug/L
cis-1,2-Dichloroethene	ND	1.2	ug/L
trans-1,2-Dichloroethene	ND	0.60	ug/L
1,2-Dichloropropane	ND	0.50	ug/L
1,3-Dichloropropane	ND	0.50	ug/L
2,2-Dichloropropane	ND	3.5	ug/L
1,1-Dichloropropene	ND	1.0	ug/L
cis-1,3-Dichloropropene	ND	1.0	ug/L
trans-1,3-Dichloropropene	ND	1.0	ug/L
Ethylbenzene	ND	0.60	ug/L
Trichlorofluoromethane	ND	0.80	ug/L
Hexachlorobutadiene	ND	1.1	ug/L
Isopropylbenzene	ND	0.50	ug/L

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PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: TRIP_BLANK

GC/MS Volatiles

Lot-Sample #...: D8L040119-013 Work Order #...: CP2MR101 Matrix.........: WQ

PARAMETER	RESULT	REPORTING LIMIT	UNITS
p-Isopropyltoluene	ND	1.2	ug/L
Methylene chloride	**9.4**	**5.0**	**ug/L**
Naphthalene	ND	1.0	ug/L
n-Propylbenzene	ND	0.50	ug/L
Styrene	ND	0.50	ug/L
1,1,1,2-Tetrachloroethane	ND	0.50	ug/L
1,1,2,2-Tetrachloroethane	ND	0.50	ug/L
Tetrachloroethene	ND	1.4	ug/L
Toluene	ND	1.1	ug/L
1,2,3-Trichlorobenzene	ND	0.50	ug/L
1,2,4-Trichlorobenzene	ND	0.50	ug/L
1,1,1-Trichloroethane	ND	0.80	ug/L
1,1,2-Trichloroethane	ND	1.0	ug/L
Trichloroethene	ND	1.0	ug/L
1,2,3-Trichloropropane	ND	3.2	ug/L
1,2,4-Trimethylbenzene	ND	1.3	ug/L
1,3,5-Trimethylbenzene	ND	0.50	ug/L
Vinyl chloride	ND	1.0	ug/L
o-Xylene	ND	1.1	ug/L
m-Xylene & p-Xylene	ND	1.0	ug/L
1,2-Dibromo-3-chloropropane (DBCP)	ND	2.6	ug/L
1,2-Dibromoethane (EDB)	ND	0.60	ug/L

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Dibromofluoromethane	104	(75 - 125)
Toluene-d8	101	(75 - 125)
4-Bromofluorobenzene	100	(75 - 125)
1,2-Dichloroethane-d4	98	(62 - 139)

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJSB1-4

GC/MS Semivolatiles

Lot-Sample #...: D8L040119-001 Work Order #...: CP0H8101 Matrix.........: SO
Date Sampled...: 12/03/98 09:30 Date Received..: 12/04/98
Prep Date......: 12/08/98 Analysis Date..: 01/13/99
Prep Batch #...: 8342215 Analysis Time..: 14:00
Dilution Factor: 10
% Moisture.....: 6.6 Method.........: SW846 8270B

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Acenaphthene	ND	7.5	mg/kg
Acenaphthylene	ND	7.5	mg/kg
Anthracene	ND	7.5	mg/kg
Benzo(a)anthracene	ND	7.5	mg/kg
Benzo(b)fluoranthene	ND	7.5	mg/kg
Benzoic acid	ND	17	mg/kg
Benzo(ghi)perylene	ND	7.5	mg/kg
Benzo(a)pyrene	ND	7.5	mg/kg
bis(2-Chloroethoxy) methane	ND	7.5	mg/kg
bis(2-Chloroethyl) ether	ND	7.5	mg/kg
bis(2-Ethylhexyl) phthalate	ND	7.5	mg/kg
4-Bromophenyl phenyl ether	ND	7.5	mg/kg
Butyl benzyl phthalate	ND	7.5	mg/kg
4-Chloroaniline	ND	14	mg/kg
4-Chloro-3-methylphenol	ND	14	mg/kg
2-Chlorophenol	ND	7.5	mg/kg
4-Chlorophenyl phenyl ether	ND	7.5	mg/kg
Chrysene	ND	7.5	mg/kg
Dibenz(a,h)anthracene	ND	7.5	mg/kg
Dibenzofuran	ND	7.5	mg/kg
1,2-Dichlorobenzene	ND	7.5	mg/kg
1,3-Dichlorobenzene	ND	7.5	mg/kg
1,4-Dichlorobenzene	ND	7.5	mg/kg
3,3'-Dichlorobenzidine	ND	14	mg/kg
2,4-Dichlorophenol	ND	3.2	mg/kg
Diethyl phthalate	ND	7.5	mg/kg
2,4-Dimethylphenol	ND	3.2	mg/kg
Dimethyl phthalate	ND	7.5	mg/kg
4,6-Dinitro-2-methylphenol	ND	35	mg/kg
2,4-Dinitrophenol	ND	35	mg/kg
2,4-Dinitrotoluene	ND	7.5	mg/kg
2,6-Dinitrotoluene	ND	7.5	mg/kg
Di-n-octyl phthalate	ND	7.5	mg/kg

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PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJSB1-4

GC/MS Semivolatiles

Lot-Sample #...: D8L040119-001 Work Order #...: CP0H8101 Matrix.........: SO

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Fluoranthene	ND	7.5	mg/kg
Fluorene	ND	7.5	mg/kg
Hexachlorobenzene	ND	7.5	mg/kg
Hexachlorobutadiene	ND	7.5	mg/kg
Hexachlorocyclopentadiene	ND	7.5	mg/kg
Hexachloroethane	ND	7.5	mg/kg
Indeno(1,2,3-cd)pyrene	ND	7.5	mg/kg
Isophorone	ND	7.5	mg/kg
2-Methylnaphthalene	**31**	**7.5**	**mg/kg**
2-Methylphenol	ND	3.2	mg/kg
Naphthalene	**31**	**7.5**	**mg/kg**
2-Nitroaniline	ND	35	mg/kg
3-Nitroaniline	ND	35	mg/kg
4-Nitroaniline	ND	35	mg/kg
Nitrobenzene	ND	7.5	mg/kg
2-Nitrophenol	ND	3.2	mg/kg
4-Nitrophenol	ND	17	mg/kg
N-Nitrosodiphenylamine	ND	7.5	mg/kg
N-Nitrosodi-n-propylamine	ND	7.5	mg/kg
Pentachlorophenol	ND	35	mg/kg
Phenanthrene	ND	7.5	mg/kg
Phenol	ND	3.2	mg/kg
Pyrene	ND	7.5	mg/kg
1,2,4-Trichlorobenzene	ND	7.5	mg/kg
2,4,5-Trichlorophenol	ND	35	mg/kg
Benzyl alcohol	ND	14	mg/kg
bis(2-Chloroisopropyl) ether	ND	7.5	mg/kg
2-Chloronaphthalene	ND	7.5	mg/kg
Di-n-butyl phthalate	ND	7.5	mg/kg
4-Methylphenol	ND	3.2	mg/kg
2,4,6-Trichlorophenol	ND	3.2	mg/kg

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
2,4,6-Tribromophenol	50 DIL	(25 - 144)
2-Fluorobiphenyl	69 DIL	(34 - 135)
2-Fluorophenol	57 DIL	(25 - 135)
Nitrobenzene-d5	98 DIL	(25 - 135)
Phenol-d5	59 DIL	(25 - 135)
Terphenyl-d14	79 DIL	(32 - 136)

NOTE(S):

DIL The concentration is estimated or not reported due to dilution or the presence of interfering analytes.

ults and reporting limits have been adjusted for dry weight.

evated reporting limits. The reporting limits are elevated due to matrix interference.

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJSB2-3

GC/MS Semivolatiles

Lot-Sample #...: D8L040119-003 Work Order #...: CP0HE101 Matrix.........: SO
Date Sampled...: 12/02/98 12:00 Date Received..: 12/04/98
Prep Date......: 12/08/98 Analysis Date..: 01/13/99
Prep Batch #...: 8342215 Analysis Time..: 14:36
Dilution Factor: 4
% Moisture.....: 13 Method.........: SW846 8270B

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Acenaphthene	ND	3.2	mg/kg
Acenaphthylene	ND	3.2	mg/kg
Anthracene	ND	3.2	mg/kg
Benzo(a)anthracene	ND	3.2	mg/kg
Benzo(b)fluoranthene	ND	3.2	mg/kg
Benzoic acid	ND	7.4	mg/kg
Benzo(ghi)perylene	ND	3.2	mg/kg
Benzo(a)pyrene	ND	3.2	mg/kg
bis(2-Chloroethoxy) methane	ND	3.2	mg/kg
bis(2-Chloroethyl) ether	ND	3.2	mg/kg
bis(2-Ethylhexyl) phthalate	ND	3.2	mg/kg
4-Bromophenyl phenyl ether	ND	3.2	mg/kg
Butyl benzyl phthalate	ND	3.2	mg/kg
4-Chloroaniline	ND	6.0	mg/kg
4-Chloro-3-methylphenol	ND	6.0	mg/kg
2-Chlorophenol	ND	3.2	mg/kg
4-Chlorophenyl phenyl ether	ND	3.2	mg/kg
Chrysene	ND	3.2	mg/kg
Dibenz(a,h)anthracene	ND	3.2	mg/kg
Dibenzofuran	ND	3.2	mg/kg
1,2-Dichlorobenzene	ND	3.2	mg/kg
1,3-Dichlorobenzene	ND	3.2	mg/kg
1,4-Dichlorobenzene	ND	3.2	mg/kg
3,3'-Dichlorobenzidine	ND	6.0	mg/kg
2,4-Dichlorophenol	ND	1.4	mg/kg
Diethyl phthalate	ND	3.2	mg/kg
2,4-Dimethylphenol	ND	1.4	mg/kg
Dimethyl phthalate	ND	3.2	mg/kg
4,6-Dinitro-2-methylphenol	ND	15	mg/kg
2,4-Dinitrophenol	ND	15	mg/kg
2,4-Dinitrotoluene	ND	3.2	mg/kg
2,6-Dinitrotoluene	ND	3.2	mg/kg
Di-n-octyl phthalate	ND	3.2	mg/kg

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PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJSB2-3

GC/MS Semivolatiles

Lot-Sample #...: D8L040119-003 Work Order #...: CP0HE101 Matrix.........: SO

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Fluoranthene	ND	3.2	mg/kg
Fluorene	ND	3.2	mg/kg
Hexachlorobenzene	ND	3.2	mg/kg
Hexachlorobutadiene	ND	3.2	mg/kg
Hexachlorocyclopentadiene	ND	3.2	mg/kg
Hexachloroethane	ND	3.2	mg/kg
Indeno(1,2,3-cd)pyrene	ND	3.2	mg/kg
Isophorone	ND	3.2	mg/kg
2-Methylnaphthalene	**8.9**	**3.2**	**mg/kg**
2-Methylphenol	ND	1.4	mg/kg
Naphthalene	**7.2**	**3.2**	**mg/kg**
2-Nitroaniline	ND	15	mg/kg
3-Nitroaniline	ND	15	mg/kg
4-Nitroaniline	ND	15	mg/kg
Nitrobenzene	ND	3.2	mg/kg
2-Nitrophenol	ND	1.4	mg/kg
4-Nitrophenol	ND	7.4	mg/kg
N-Nitrosodiphenylamine	ND	3.2	mg/kg
N-Nitrosodi-n-propylamine	ND	3.2	mg/kg
Pentachlorophenol	ND	15	mg/kg
Phenanthrene	ND	3.2	mg/kg
Phenol	ND	1.4	mg/kg
Pyrene	ND	3.2	mg/kg
1,2,4-Trichlorobenzene	ND	3.2	mg/kg
2,4,5-Trichlorophenol	ND	15	mg/kg
Benzyl alcohol	ND	6.0	mg/kg
bis(2-Chloroisopropyl) ether	ND	3.2	mg/kg
2-Chloronaphthalene	ND	3.2	mg/kg
Di-n-butyl phthalate	ND	3.2	mg/kg
4-Methylphenol	ND	1.4	mg/kg
2,4,6-Trichlorophenol	ND	1.4	mg/kg

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
2,4,6-Tribromophenol	58 DIL	(25 - 144)
2-Fluorobiphenyl	67 DIL	(34 - 135)
2-Fluorophenol	73 DIL	(25 - 135)
Nitrobenzene-d5	81 DIL	(25 - 135)
Phenol-d5	63 DIL	(25 - 135)
Terphenyl-d14	80 DIL	(32 - 136)

NOTE(S):

DIL The concentration is estimated or not reported due to dilution or the presence of interfering analytes.

Results and reporting limits have been adjusted for dry weight.

Elevated reporting limits. The reporting limits are elevated due to matrix interference.

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJSB3-4.5

GC/MS Semivolatiles

Lot-Sample #...: D8L040119-005   Work Order #...: CP0HG101   Matrix.........: SO
Date Sampled...: 12/03/98 10:30   Date Received..: 12/04/98
Prep Date......: 12/08/98   Analysis Date..: 01/13/99
Prep Batch #...: 8342215   Analysis Time..: 12:12
Dilution Factor: 1
% Moisture.....: 8.7   Method.........: SW846 8270B

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Acenaphthene	ND	0.77	mg/kg
Acenaphthylene	ND	0.77	mg/kg
Anthracene	ND	0.77	mg/kg
Benzo(a)anthracene	ND	0.77	mg/kg
Benzo(b)fluoranthene	ND	0.77	mg/kg
Benzoic acid	ND	1.8	mg/kg
Benzo(ghi)perylene	ND	0.77	mg/kg
Benzo(a)pyrene	ND	0.77	mg/kg
bis(2-Chloroethoxy) methane	ND	0.77	mg/kg
bis(2-Chloroethyl) ether	ND	0.77	mg/kg
bis(2-Ethylhexyl) phthalate	ND	0.77	mg/kg
4-Bromophenyl phenyl ether	ND	0.77	mg/kg
Butyl benzyl phthalate	ND	0.77	mg/kg
4-Chloroaniline	ND	1.4	mg/kg
4-Chloro-3-methylphenol	ND	1.4	mg/kg
2-Chlorophenol	ND	0.77	mg/kg
4-Chlorophenyl phenyl ether	ND	0.77	mg/kg
Chrysene	ND	0.77	mg/kg
Dibenzofuran	ND	0.77	mg/kg
1,2-Dichlorobenzene	ND	0.77	mg/kg
1,3-Dichlorobenzene	ND	0.77	mg/kg
1,4-Dichlorobenzene	ND	0.77	mg/kg
3,3'-Dichlorobenzidine	ND	1.4	mg/kg
2,4-Dichlorophenol	ND	0.33	mg/kg
Diethyl phthalate	ND	0.77	mg/kg
2,4-Dimethylphenol	ND	0.33	mg/kg
Dimethyl phthalate	ND	0.77	mg/kg
4,6-Dinitro-2-methylphenol	ND	3.6	mg/kg
2,4-Dinitrophenol	ND	3.6	mg/kg
2,4-Dinitrotoluene	ND	0.77	mg/kg
2,6-Dinitrotoluene	ND	0.77	mg/kg
Di-n-octyl phthalate	ND	0.77	mg/kg
Fluoranthene	ND	0.77	mg/kg

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PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJSB3-4.5

GC/MS Semivolatiles

Lot-Sample #...: D8L040119-005 Work Order #...: CP0HG101 Matrix.........: SO

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Fluorene	ND	0.77	mg/kg
Hexachlorobenzene	ND	0.77	mg/kg
Hexachlorobutadiene	ND	0.77	mg/kg
Hexachlorocyclopentadiene	ND	0.77	mg/kg
Hexachloroethane	ND	0.77	mg/kg
Indeno(1,2,3-cd)pyrene	ND	0.77	mg/kg
Isophorone	ND	0.77	mg/kg
2-Methylnaphthalene	ND	0.77	mg/kg
2-Methylphenol	ND	0.33	mg/kg
Naphthalene	ND	0.77	mg/kg
2-Nitroaniline	ND	3.6	mg/kg
3-Nitroaniline	ND	3.6	mg/kg
4-Nitroaniline	ND	3.6	mg/kg
Nitrobenzene	ND	0.77	mg/kg
2-Nitrophenol	ND	0.33	mg/kg
4-Nitrophenol	ND	1.8	mg/kg
N-Nitrosodiphenylamine	ND	0.77	mg/kg
N-Nitrosodi-n-propylamine	ND	0.77	mg/kg
Pentachlorophenol	ND	3.6	mg/kg
Phenanthrene	ND	0.77	mg/kg
Phenol	ND	0.33	mg/kg
Pyrene	ND	0.77	mg/kg
1,2,4-Trichlorobenzene	ND	0.77	mg/kg
2,4,5-Trichlorophenol	ND	3.6	mg/kg
Benzyl alcohol	ND	1.4	mg/kg
bis(2-Chloroisopropyl) ether	ND	0.77	mg/kg
2-Chloronaphthalene	ND	0.77	mg/kg
Di-n-butyl phthalate	ND	0.77	mg/kg
4-Methylphenol	ND	0.33	mg/kg
2,4,6-Trichlorophenol	ND	0.33	mg/kg

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
2,4,6-Tribromophenol	74	(25 - 144)
2-Fluorobiphenyl	65	(34 - 135)
2-Fluorophenol	88	(25 - 135)
Nitrobenzene-d5	70	(25 - 135)
Phenol-d5	71	(25 - 135)
Terphenyl-d14	89	(32 - 136)

NOTE(S):

Results and reporting limits have been adjusted for dry weight.

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJSB4-5

General Chemistry

Lot-Sample #...: D8L040119-007   Work Order #...: CP0HQ   Matrix..........: SO
Date Sampled...: 12/01/98 16:00   Date Received..: 12/04/98
% Moisture.....:

PARAMETER	RESULT	RL	UNITS	METHOD	PREPARATION-ANALYSIS DATE	PREP BATCH #
Total Organic Carbon	590 F	2000	mg/kg	SW846 9060	12/21-12/22/98	8356336
		Dilution Factor: 1		Analysis Time..: 11:00		

NOTE(S):

RL Reporting Limit

F The analyte was positively identified, but the associated value is below the RL

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJSB5-3

General Chemistry

Lot-Sample #...: D8L040119-008
Date Sampled...: 12/02/98 16:30
% Moisture.....:

Work Order #...: CP0J6
Date Received..: 12/04/98

Matrix.........: SO

PARAMETER	RESULT	RL	UNITS	METHOD	PREPARATION-ANALYSIS DATE	PR BA
Total Organic Carbon	1980 F	2000	mg/kg	SW846 9060	12/21-12/22/98	83
		Dilution Factor: 1		Analysis Time..: 11:00		

NOTE(S):

RL Reporting Limit

F The analyte was positively identified, but the associated value is below the RL

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJMP-B

General Chemistry

Lot-Sample #...: D8L040119-009 Work Order #...: CP0J8 Matrix..........: WG
Date Sampled...: 12/03/98 10:10 Date Received..: 12/04/98

PARAMETER	RESULT	RL	UNITS	METHOD	PREPARATION-ANALYSIS DATE	PR: BA:
Nitrate	ND	1.0	mg/L	SW846 9056	12/04-12/05/98	834
		Dilution Factor: 1		Analysis Time..: 07:34		

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJMW-5

General Chemistry

Lot-Sample #...: D8L040119-010 Work Order #...: CP0JN Matrix.........: WG
Date Sampled...: 12/03/98 11:30 Date Received..: 12/04/98

PARAMETER	RESULT	RL	UNITS	METHOD	PREPARATION-ANALYSIS DATE	PREP BATCH #
Nitrate	0.41 F	1.0	mg/L	SW846 9056	12/04-12/05/98	8346171
		Dilution Factor: 1		Analysis Time..: 08:24		

NOTE(S):

RL Reporting Limit

F The analyte was positively identified, but the associated value is below the RL

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJMW-4

General Chemistry

Lot-Sample #...: D8L040119-011 Work Order #...: CP0K1 Matrix..........: WG
Date Sampled...: 12/03/98 09:30 Date Received..: 12/04/98

PARAMETER	RESULT	RL	UNITS	METHOD	PREPARATION-ANALYSIS DATE	PREP BATCH #
Nitrate	ND	1.0	mg/L	SW846 9056	12/04-12/05/98	8346171
		Dilution Factor: 1		Analysis Time..: 09:14		

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJMW-2

General Chemistry

Lot-Sample #...: D8L040119-012 Work Order #...: CP0K4 Matrix..........: WG
Date Sampled...: 12/03/98 12:10 Date Received..: 12/04/98

PARAMETER	RESULT	RL	UNITS	METHOD	PREPARATION-ANALYSIS DATE	PREP BATCH
Nitrate	ND	1.0	mg/L	SW846 9056	12/04-12/05/98	83461
		Dilution Factor: 1		Analysis Time..: 09:30		

Parsons - Seymour Johnson

A-4187

Quanterra Environmental Services

ect ID/Client: D8L040119 #2,4,6 / D8L110138 #4 (Parsons Pope AFB)

Sample Numbers

NCM Log Number: 15797

rst/Team: M. Hoffner

NCM Initiated by/Date: MH 12/17/98

Project Manager

8260

lytical Area (check appropriate box)

- ample control
- [ ] Organic preparation
- [ ] Inorganic preparation
- [ ] GC
- [ ] HPLC
- [x] GC/MS
- [ ] Wet chemistry
- etals
- [ ] Reporting
- [ ] Data review
- [ ] Radiochemistry
- [ ] ______

Conformance (check appropriate box) To be completed by analyst

ng Time Violation (exceeded by ______ days)

ory I: Laboratory Independent

Holding time expired in transit

ample received > 48 hours or 1/2 holding time has expired

est added by client after expiration

II: Laboratory Dependent

trument failure

alyst error

-in error

ommunication

r (explanation required)

: Analysis Reruns (QA/QC)

gates

nal standards

recoveries

contamination

Analysis Reruns (Confirmation)

d column

ination check

ation of matrix effects

xplanation required) ______

Quality Assurance/Quality Control

- [x] 17. QC data reported outside of controls
- [ ] 18. Incorrect procedure used
- [ ] 19. SOP intentionally modified with QA and tech approval
- [ ] 20. Invalid instrument calibration
- [ ] 21. Received insuffient sample for proper analysis

Incorrect or Incomplete Client Deliverable

- [ ] 22. Hardcopy deliverable error
- [ ] 23. Electronic deliverable error

Reported Detection Limits Elevated Due to:

- [ ] 24. Sample matrix: Does not include high analyte content
- [ ] 25. Insufficient sample volume
- [ ] 26. Other (explanation required)

Miscellaneous

- [ ] 27. Instrument Tag-out
- [ ] 28. Other (explanation required) ______

ck appropriate box) To be completed by project manager

- [ ] **Not Required**

re | Date 12/21/98 | [ ] In writing [ ] By telephone [ ] By facsimile [ ] Other (explain) ______

e | [x] Process "as is" [ ] On hold until ______ [ ] Re-sample [ ] Other (explain) ______

LaRiviere

Date 12/21/98

Laboratory Non-Conformance Memo (NCM)

Quanterra
Environmental Services

NCM Log Number 15797

...487

...ive Action (To be completed and reviewed by all associates involved)

Pr...cription/Root Cause The LCS/LCSD has two compound outside acceptance limits. Bromomethane is recovered at 56% and 54% (limits 65-135), Dichlorodifluoromethane is recovered at 26% and 24% (limits 65-135). The cause of this is these gases are lost during a medium level soil prep. They are NOT AS VOLATILE IN LOW-level prep.
Cmpd is NOT CONTROLLED in MS/MSD (& DID FAIL THERE ALSO)

Author's initials and date MMA 12/17/98

Corrective Actions (Short Term) Report Data with footnotes

Author's initials and date w 12/18/98

Corrective Actions to Prevent Reoccurance (Long Term) Look at Control Limit in Reference to med Level Extracts

Corrective Action approved by (Supervisor/Group Leader) and date CmRL 12/18/98

Additional Comments

Corrective Action to be completed by (if other than Supervisor/Group Leader)

Date Corrective Action is to be completed

Quality Assurance Review (To be completed by a QA associate)

Log ID ☐ Anomaly ☐ Deficiency ☐ Notified Ops/Sys Manager (Initials)

☐ Further action required

☐ Further action assigned to

QA signature

Date

Corrective Action Verification (To be completed by a QA associate)

☐ Verification not required or requested ☐ Verified/CA completed on ________ by

☐ Cannot verifiy (specify reason)

Date

Nonconformance Memo Closure

QA signature

Date

The office of Quality Assurance maintains a copy of this NCM indicating its final status.

Chain of Custody Record

D8L040119

Quanterra

94

QUA-4124 0797

Client	Parsons Engineering Science, Inc
Address	1700 Broadway Suite 900
City	Denver
State	CO
Zip Code	80290
Project Name	AFCEE - RBCA Investigation
Contract/Purchase Order/Quote No.	731854.05000
Project Manager	John Hicks
Telephone Number (Area Code)/Fax Number	303-831-8100 fax - 8208
Site Contact	Tom Drager
Lab Contact	John Mitchell
Carrier/Waybill Number	
Date	12-3-98
Lab Number	
Chain of Custody Number	20259
Page	1 of 2

	Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Aqueous	Sed.	Soil	Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/NaOH	SW8270 Svoc	SW8260 VOC	SW9060M TOC	Nitrate E300	Special Instructions/ Conditions of Receipt
1	98SJSB1-4	12-3-98	0930			X	X						X				8 oz.
2	98SJSB1-2.5	12-3-98	0930			X	X							X			Liner
3	98SJSB2-3	12-2-98	1200			X	X						X				8 oz.
4	98SJSB2-4	12-2-98	1200			X	X							X			Liner
5	98SJSB3-4.5	12-3-98	1030			X	X						X				8 oz. Also run MS/MS
6	98SJSB3-5.5	12-3-98	1030			X	X							X			Liner
7	98SJSB4-5	12-1-98	1600			X	X								X		Liner Also run MS/MSD
8	98SJSB5-3	12-2-98	1630												X		Liner
9	98SJMP~~2~~-B	12-3-98	1010	X			X									X	1L Poly
9a	98SJMP-B	12-3-98	1010	X			X									X	1L Poly Also run MS
	98SJMP-B	12-3-98	1010	X			X									X	1L Poly Also run MSD
10	98SJMW5	12-3-98	1130	X			X									X	1L Poly

Possible Hazard Identification: ☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☒ Unknown

Sample Disposal: ☐ Return To Client ☐ Disposal By Lab ☒ Archive For 3 Months (A fee may be assessed if samples are retained longer than 3 months)

Turn Around Time Required: ☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☐ 14 Days ☐ 21 Days ☐ Other

QC Requirements (Specify): MS/MSD on requested samples only * 48 hr. hold on Nitrates

	Date	Time		Date	Time
1. Relinquished By: Tom Drager [signature]	12-3-98	1500	1. Received By: [signature]	12/3/98	0900
2. Relinquished By			2. Received By		
3. Relinquished By			3. Received By		

Comments

DISTRIBUTIO[N: WHI]TE - Stays with the Sample; CANARY - Returned to Client with Report; PINK - Field Co[py]

[redacted]

Chain of Custody Record

8L040119

Quanterra

QUA-4124 0797

Client	Project Manager	Date	Chain of Custody Number
Parsons Engineering Science, Inc	John Hicks	12-3-98	20252

Address	Telephone Number (Area Code)/Fax Number	Lab Number	Page
1700 Broadway Suite 900	303-831-8100 Fax - 8208		Page 2 of 2

City	State	Zip Code	Site Contact	Lab Contact
Denver	CO	80290	Tom Drasgo	John Mitchell

Project Name: AFCEE RBCA Investigation

Carrier/Waybill Number:

Contract/Purchase Order/Quote No.: 731854.05000

	Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Matrix: Aqueous	Matrix: Sed.	Matrix: Soil	Containers & Preservatives: Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/NaOH	Analysis (Attach list if more space is needed): Nitrate E300	Special Instructions/ Conditions of Receipt
-011	985JMW4	12-3-98	0930	X			X						X	1L Poly
-012	985JMW2	12-3-98	1210	X			X						X	1L Poly
-013	Trip Blanks	12-3-98												2 VOAs
	Temperature Blank													1 Scoml Poly

Possible Hazard Identification: ☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☒ Unknown

Sample Disposal: ☐ Return To Client ☐ Disposal By Lab ☒ Archive For 3 Months (A fee may be assessed if samples are retained longer than 3 months)

Turn Around Time Required: ☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☐ 14 Days ☐ 21 Days ☐ Other

QC Requirements (Specify): MS/MSD on requested samples only. * 48 hour hold on Nitrate Sample

Relinquished By	Date	Time	Received By	Date	Time
1. Tom Drasgo [signature]	12-3-98	1500	1. [signature]	12/4/98	0900
2.			2.		
3.			3.		

Comments

DISTRIBUTION: WHITE - Stays with the Sample; CANARY - Returned to Client with Report; PINK - Field Copy

AMPLE CHECKLIST

ot #: D8L040119 Date/Time Received: 12/4/98 0900

Company Name & Sampling Site: Parsons

*Cooler #(s): 1

Temperatures: 4.3

Unpacking & Labeling Check Points:

NA	Yes	No		Initials
	☑	☐	1. Radiation checked, record if reading > 0.5 mR/hr. (mR/hr)	NJ
	☑	☐	2. Cooler seals intact.	
	☑	☐	3. Chain of custody present.	
	☐	☑	4. Bottles broken and/or are leaking, comment if yes.	
			PHOTOGRAPH BROKEN BOTTLES	
	☑	☐	5. Containers labeled, comment if no.	
	☑	☐	6. pH of all samples checked and meet requirements, note exceptions.	
	☑	☐	7. Chain of custody includes "received by" and "relinquished" by signatures, dates, and times.	
	☐	☑	8. Receipt date(s) > 48 hours past the collection date(s)? If yes, notify PA/PM.	
	☑	☐	9. Chain of custody agrees with bottle count, comment if no.	
	☑	☐	10. Chain of custody agrees with labels, comment if no.	
☑	☐	☐	11. VOA samples filled completely, comment if no.	
☐	☐	☐	12. VOA bottles preserved, check for labels.	
	☐	☑	13. Did samples require preservation with sodium thiosulfate?	
☐	☐	☑	14. If yes to #12, did the samples contain residual chlorine?	
☐	☐	☑	15. Sediment present in "D," dissolved, bottles.	
	☑	☐	16. Are analyses with short holding times requested?	
☐	☑	☐	17. Is extra sample volume provided for MS, MSD or matrix duplicates?	
	☐	☑	18. Multiphase samples present? If yes, comment below.	
	☐	☑	19. Any subsampling for volatiles? If yes, list samples.	
			PHOTOGRAPH MULTIPHASE SAMPLES	
☐	☐	☐	20. Clear picture taken, labeled, and stapled to project folder.	
☐	☐	☐	21. Subcontract COC signed and sent with samples to bottle prep?	
	☐	☐	22. Was sample labeling double checked?	

Comments: Include action taken to resolve discrepancies/problems. Include a hard copy of e-mail or use extra paper if more space is needed.

Initials:

Revision 4 6/25/9?

OAVFORMS\SAMPLE RECEIVING\SAMPCHCK.DOC

Quanterra

Quanterra Incorporated
4955 Yarrow Street
Arvada, Colorado 80002

303 421-6611 Telephone
303 431-7171 Fax

ANALYTICAL REPORT

Seymour Johnson AFB
Lot #: D8L050133

John Hicks

Parsons Engineering Services

QUANTERRA INCORPORATED

Ellen La Riviere

Ellen La Riviere
Project Manager

January 19, 1999

Table Of Contents

Standard Deliverables With Supporting Documentation

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Project Narrative
(D8L050133)

GC/MS Semi-Volatiles

The extraction lab ran out of all analyte spike, and it was not possible to obtain a new supply prior to sample expiration. Therefore, an expired all analyte spike standard (V11292) was used to prepare the LCS/LCSD and MS/MSD for QC Batch 8344205. The expired standard was re-verified, but the re-verification showed that Benzidine and 3,3'-Dichlorobenzidine had degraded and were no longer present in the expired standard.

The MS is the primary control sample for Method 625. The LCS is used as a backup for the MS.

As expected, the recoveries of Benzidine and 3,3'-Dichlorobenzidine were out of control in the MS/MSD associated with samples D8L050133-001 and -002. The LCS/LCSD associated with these samples was also out-of-control for Benzidine and 3,3'-Dichlorobenzidine. Since it can be shown that these compounds were out-of-control because the spiking standard had degraded, no corrective action was taken.

The relative percent differences for 1,2-diphenylhydrazine, hexachlorocyclopentadiene and H-nitrosodiphenylamine also exceeded the control limits in the LCS/LCSD associated with the Method 625 batch 8344205. Because these compounds were within acceptable limits in the MS/MSD, no further action was required by the Method.

Polynuclear Aromatic Hydrocarbons

Dibenzo(a,h)anthracene was recovered above the upper control limits in the LCS/LCSD associated with the samples in this project. Because this would indicate a high bias to the data, and this compound was not detected in the samples, no further action was required.

EXECUTIVE SUMMARY - Detection Highlights

D8L050133

PARAMETER	RESULT	REPORTING LIMIT	UNITS	ANALYTICAL METHOD
98SJMW-4 12/03/98 09:30 001				
Naphthalene	210	5.0	ug/L	SW846 8310
Naphthalene	210	5.0	ug/L	SW846 8310
Naphthalene	180	5.0	ug/L	SW846 8310
2,4-Dimethylphenol	12	10	ug/L	CFR136A 625
Naphthalene	110	10	ug/L	CFR136A 625
98SJMP-B 12/03/98 10:10 002				
Naphthalene	190	5.0	ug/L	SW846 8310
Naphthalene	190	5.0	ug/L	SW846 8310
Naphthalene	170	5.0	ug/L	SW846 8310
2,4-Dimethylphenol	2.6 J	10	ug/L	CFR136A 625
Naphthalene	140	10	ug/L	CFR136A 625

ANALYTICAL METHODS SUMMARY

D8L050133

PARAMETER	ANALYTICAL METHOD
Base/Neutrals and Acids	CFR136A 625
Polynuclear Aromatic Hydrocarbons by HPLC	SW846 8310

References:

CFR136A "Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater", 40CFR, Part 136, Appendix A, October 26, 1984 and subsequent revisions.

SW846 "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 and its updates.

METHOD / ANALYST SUMMARY

D8L050133

ANALYTICAL METHOD	ANALYST	ANALYST ID
CFR136A 625	Robert P. Guthrie	001593
SW846 8310	Dane Rodgers	007407

References:

CFR136A "Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater", 40CFR, Part 136, Appendix A, October 26, 1984 and subsequent revisions.

SW846 "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 and its updates.

SAMPLE SUMMARY

D8L050133

WO #	SAMPLE#	CLIENT SAMPLE ID	DATE	TIMI
CP1X4	001	98SJMW-4	12/03/98	09:[illegible]
CP1X8	002	98SJMP-B	12/03/98	10:[illegible]

NOTE(S):

- The analytical results of the samples listed above are presented on the following pages.
- All calculations are performed before rounding to avoid round-off errors in calculated results.
- Results noted as "ND" were not detected at or above the stated limit.
- This report must not be reproduced, except in full, without the written approval of the laboratory.
- Results for the following parameters are never reported on a dry weight basis: color, corrosivity, density, flashpoint, ignitability, layers, odor, paint filter test, pH, porosity pressure, reactivity, redox potential, specific gravity, spot tests, solids, solubility, temperature, viscosity, and weight.

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJMW-4

GC/MS Semivolatiles

Lot-Sample #...: D8L050133-001 Work Order #...: CP1X4101 Matrix.........: WG
Date Sampled...: 12/03/98 09:30 Date Received..: 12/05/98
Prep Date......: 12/10/98 Analysis Date..: 01/14/99
Prep Batch #...: 8344205 Analysis Time..: 01:05
Dilution Factor: 1

Method.........: CFR136A 625

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Acenaphthene	ND	10	ug/L
Acenaphthylene	ND	10	ug/L
Anthracene	ND	10	ug/L
Benzidine	ND	100	ug/L
Benzo(a)anthracene	ND	10	ug/L
Benzo(b)fluoranthene	ND	10	ug/L
Benzo(ghi)perylene	ND	10	ug/L
Benzo(k)fluoranthene	ND	10	ug/L
Benzo(a)pyrene	ND	10	ug/L
4-Bromophenyl phenyl ether	ND	10	ug/L
Butyl benzyl phthalate	ND	10	ug/L
bis(2-Chloroethoxy) methane	ND	10	ug/L
bis(2-Chloroethyl) ether	ND	10	ug/L
bis(2-Chloroisopropyl) ether	ND	10	ug/L
4-Chloro-3-methylphenol	ND	10	ug/L
2-Chloronaphthalene	ND	10	ug/L
2-Chlorophenol	ND	10	ug/L
4-Chlorophenyl phenyl ether	ND	10	ug/L
Chrysene	ND	10	ug/L
Di-n-butyl phthalate	ND	10	ug/L
1,2-Dichlorobenzene	ND	10	ug/L
1,3-Dichlorobenzene	ND	10	ug/L
1,4-Dichlorobenzene	ND	10	ug/L
3,3'-Dichlorobenzidine	ND	50	ug/L
2,4-Dichlorophenol	ND	10	ug/L
Diethyl phthalate	ND	10	ug/L
2,4-Dimethylphenol	**12**	**10**	**ug/L**
Dimethyl phthalate	ND	10	ug/L
2,4-Dinitrophenol	ND	50	ug/L
2,4-Dinitrotoluene	ND	10	ug/L
2,6-Dinitrotoluene	ND	10	ug/L
Di-n-octyl phthalate	ND	10	ug/L
1,2-Diphenylhydrazine	ND	10	ug/L
bis(2-Ethylhexyl) phthalate	ND	10	ug/L

(Continued on next page)

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJMW-4

GC/MS Semivolatiles

Lot-Sample #...: D8L050133-001 Work Order #...: CP1X4101 Matrix.........: WG

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Fluoranthene	ND	10	ug/L
Fluorene	ND	10	ug/L
Hexachlorobenzene	ND	10	ug/L
Hexachlorobutadiene	ND	10	ug/L
Hexachlorocyclopentadiene	ND	50	ug/L
Hexachloroethane	ND	10	ug/L
Indeno(1,2,3-cd)pyrene	ND	10	ug/L
Isophorone	ND	10	ug/L
Naphthalene	**110**	**10**	**ug/L**
Nitrobenzene	ND	10	ug/L
2-Nitrophenol	ND	10	ug/L
4-Nitrophenol	ND	50	ug/L
N-Nitrosodimethylamine	ND	10	ug/L
N-Nitrosodi-n-propylamine	ND	10	ug/L
N-Nitrosodiphenylamine	ND	10	ug/L
Pentachlorophenol	ND	10	ug/L
Phenanthrene	ND	50	ug/L
Phenol	ND	10	ug/L
Pyrene	ND	10	ug/L
1,2,4-Trichlorobenzene	ND	10	ug/L
2,4,6-Trichlorophenol	ND	10	ug/L

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
2-Fluorophenol	87	(48 - 102)
Phenol-d5	91	(46 - 110)
Nitrobenzene-d5	71	(51 - 102)
2-Fluorobiphenyl	64	(39 - 91)
2,4,6-Tribromophenol	95	(38 - 120)
Terphenyl-d14	70	(42 - 131)

PARSONS ENGINEERING SCIENCE, INC.

98SJMW-4

GC/MS Semivolatiles

Lot-Sample #: D8L050133-001 Work Order #: CP1X4101 Matrix: WG

MASS SPECTROMETER/DATA SYSTEM (MSDS) TENTATIVELY IDENTIFIED COMPOUNDS

PARAMETER	CAS #	ESTIMATED RESULT		RETENTION TIME	UNITS
Benzene, (1-methylethyl)-	98-82-8	37	M		ug/L
Benzene, propyl-	103-65-1	45	M		ug/L
Benzene, 1-ethyl-4-methyl-	622-96-8	160	M		ug/L
Benzene, 1,2,3-trimethyl- #1	526-73-8	63	M		ug/L
Benzene, 1,2,3-trimethyl- #2	526-73-8	230	M		ug/L
Benzene, 1,2,3-trimethyl- #3	526-73-8	110	M		ug/L
Benzene, 1-methyl-3-propyl-	1074-43-7	32	M		ug/L
Phenol, 4-methyl-	106-44-5	27	M		ug/L
Benzene, 4-ethyl-1,2-dimethy#1	934-80-5	30	M		ug/L
Benzene, 4-ethyl-1,2-dimethy#2	934-80-5	23	M		ug/L
Benzene, 1,2,3,4-tetramethyl-	488-23-3	22	M		ug/L
Unknown #1	57-20-0	150	M		ug/L
Benzene, 2-butenyl-	1560-06-1	46	M		ug/L
Naphthalene, 1,2,3,4-tetrahydr	119-64-2	45	M		ug/L
Naphthalene, 1-methyl-	90-12-0	48	M		ug/L
Benzeneacetic acid, .alpha.-me	492-37-5	23	M		ug/L
Unknown #3	57-20-0	26	M		ug/L
Benzoic acid, 2-methyl-	118-90-1	51	M		ug/L
Unknown #2	57-20-0	29	M		ug/L
Naphthalene, 2-methyl-	91-57-6	55	M		ug/L

NOTE(S):

M: Result was measured against nearest internal standard assuming a response factor of 1.

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJMP-B

GC/MS Semivolatiles

Lot-Sample #...: D8L050133-002 Work Order #...: CP1X8101 Matrix.........: WG
Date Sampled...: 12/03/98 10:10 Date Received..: 12/05/98
Prep Date......: 12/10/98 Analysis Date..: 01/14/99
Prep Batch #...: 8344205 Analysis Time..: 01:37
Dilution Factor: 1
Method.........: CFR136A 625

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Acenaphthene	ND	10	ug/L
Acenaphthylene	ND	10	ug/L
Anthracene	ND	10	ug/L
Benzidine	ND	100	ug/L
Benzo(a)anthracene	ND	10	ug/L
Benzo(b)fluoranthene	ND	10	ug/L
Benzo(ghi)perylene	ND	10	ug/L
Benzo(k)fluoranthene	ND	10	ug/L
Benzo(a)pyrene	ND	10	ug/L
4-Bromophenyl phenyl ether	ND	10	ug/L
Butyl benzyl phthalate	ND	10	ug/L
bis(2-Chloroethoxy) methane	ND	10	ug/L
bis(2-Chloroethyl) ether	ND	10	ug/L
bis(2-Chloroisopropyl) ether	ND	10	ug/L
4-Chloro-3-methylphenol	ND	10	ug/L
2-Chloronaphthalene	ND	10	ug/L
2-Chlorophenol	ND	10	ug/L
4-Chlorophenyl phenyl ether	ND	10	ug/L
Chrysene	ND	10	ug/L
Di-n-butyl phthalate	ND	10	ug/L
1,2-Dichlorobenzene	ND	10	ug/L
1,3-Dichlorobenzene	ND	10	ug/L
1,4-Dichlorobenzene	ND	10	ug/L
3,3'-Dichlorobenzidine	ND	50	ug/L
2,4-Dichlorophenol	ND	10	ug/L
Diethyl phthalate	ND	10	ug/L
2,4-Dimethylphenol	**2.6 J**	**10**	**ug/L**
Dimethyl phthalate	ND	10	ug/L
2,4-Dinitrophenol	ND	50	ug/L
2,4-Dinitrotoluene	ND	10	ug/L
2,6-Dinitrotoluene	ND	10	ug/L
Di-n-octyl phthalate	ND	10	ug/L
1,2-Diphenylhydrazine	ND	10	ug/L
bis(2-Ethylhexyl) phthalate	ND	10	ug/L

(Continued on next page)

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJMP-B

GC/MS Semivolatiles

Lot-Sample #...: D8L050133-002 Work Order #...: CP1X8101 Matrix.........: WG

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Fluoranthene	ND	10	ug/L
Fluorene	ND	10	ug/L
Hexachlorobenzene	ND	10	ug/L
Hexachlorobutadiene	ND	10	ug/L
Hexachlorocyclopentadiene	ND	50	ug/L
Hexachloroethane	ND	10	ug/L
Indeno(1,2,3-cd)pyrene	ND	10	ug/L
Isophorone	ND	10	ug/L
Naphthalene	**140**	**10**	**ug/L**
Nitrobenzene	ND	10	ug/L
2-Nitrophenol	ND	10	ug/L
4-Nitrophenol	ND	50	ug/L
N-Nitrosodimethylamine	ND	10	ug/L
N-Nitrosodi-n-propylamine	ND	10	ug/L
N-Nitrosodiphenylamine	ND	10	ug/L
Pentachlorophenol	ND	50	ug/L
Phenanthrene	ND	10	ug/L
Phenol	ND	10	ug/L
Pyrene	ND	10	ug/L
1,2,4-Trichlorobenzene	ND	10	ug/L
2,4,6-Trichlorophenol	ND	10	ug/L

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
2-Fluorophenol	85	(48 - 102)
Phenol-d5	87	(46 - 110)
Nitrobenzene-d5	72	(51 - 102)
2-Fluorobiphenyl	67	(39 - 91)
2,4,6-Tribromophenol	97	(38 - 120)
Terphenyl-d14	73	(42 - 131)

NOTE(S):

J Estimated result. Result is less than RL.

PARSONS ENGINEERING SCIENCE, INC.

98SJMP-B

GC/MS Semivolatiles

Lot-Sample #: D8L050133-002 **Work Order #:** CP1X8101 **Matrix:** WG

MASS SPECTROMETER/DATA SYSTEM (MSDS) TENTATIVELY IDENTIFIED COMPOUNDS

PARAMETER	CAS #	ESTIMATED RESULT		RETENTION TIME	UNITS
Benzene, (1-methylethyl)-	98-82-8	48	M		ug/L
Benzene, propyl-	103-65-1	50	M		ug/L
Benzene, 1-ethyl-3-methyl-	620-14-4	200	M		ug/L
Benzene, 1,2,3-trimethyl- #1	526-73-8	73	M		ug/L
1,2,4-Trimethylbenzene	95-36-3	260	M		ug/L
Unknown #1	57-20-0	24	M		ug/L
Unknown #3	57-20-0	18	M		ug/L
Phenol, 4-methyl-	106-44-5	19	M		ug/L
Benzene, 1-ethyl-2,4-dimethyl-	874-41-9	22	M		ug/L
Benzene, 1,2,3-trimethyl- #2	526-73-8	120	M		ug/L
Unknown #2	57-20-0	44	M		ug/L
Benzene, 1-methyl-3-propyl-	1074-43-7	28	M		ug/L
Benzene, 1-ethyl-2,3-dimethyl-	933-98-2	27	M		ug/L
Benzene, 4-ethyl-1,2-dimethyl-	934-80-5	19	M		ug/L
Benzene, 1,2,3,4-tetramethyl#1	488-23-3	19	M		ug/L
Benzene, 1,2,3,4-tetramethyl#2	488-23-3	26	M		ug/L
Unknown #4	57-20-0	63	M		ug/L
Naphthalene, 1,2,3,4-tetrahydr	119-64-2	43	M		ug/L
Naphthalene, 2-methyl- #1	91-57-6	57	M		ug/L
Naphthalene, 2-methyl- #2	91-57-6	56	M		ug/L

NOTE(S):

M: Result was measured against nearest internal standard assuming a response factor of 1.

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJMW-4

HPLC

Lot-Sample #...: D8L050133-001 Work Order #...: CP1X4102 Matrix..........: WG
Date Sampled...: 12/03/98 09:30 Date Received..: 12/05/98
Prep Date......: 12/09/98 Analysis Date..: 01/12/99
Prep Batch #...: 8343154 Analysis Time..: 15:13
Dilution Factor: 5

Method.........: SW846 8310

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Acenaphthene	ND	5.0	ug/L
Acenaphthylene	ND	5.0	ug/L
Anthracene	ND	0.50	ug/L
Benzo(a)anthracene	ND	0.65	ug/L
Benzo(a)pyrene	ND	1.2	ug/L
Benzo(b)fluoranthene	ND	0.90	ug/L
Benzo(ghi)perylene	ND	1.0	ug/L
Benzo(k)fluoranthene	ND	0.85	ug/L
Chrysene	ND	1.0	ug/L
Dibenzo(a,h)anthracene	ND	1.5	ug/L
Fluoranthene	ND	1.0	ug/L
Fluorene	ND	1.0	ug/L
Indeno(1,2,3-cd)pyrene	ND	2.2	ug/L
Naphthalene	**210**	**5.0**	**ug/L**
Phenanthrene	ND	1.0	ug/L
Pyrene	ND	1.0	ug/L

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Terphenyl-d14	0.0 DIL,*	(25 - 157)

NOTE(S):

DIL The concentration is estimated or not reported due to dilution or the presence of interfering analytes.

* Surrogate recovery is outside stated control limits.

1C

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJMW-4

HPLC

Lot-Sample #...: D8L050133-001	Work Order #...: CP1X4105	Matrix.........: WG
Date Sampled...: 12/03/98 09:30	Date Received..: 12/05/98	
Prep Date......: 12/09/98	Analysis Date..: 01/12/99	
Prep Batch #...: 8343154	Analysis Time..: 15:13	
Dilution Factor: 5		
	Method.........: SW846 8310	

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Acenaphthene	ND	5.0	ug/L
Acenaphthylene	ND	5.0	ug/L
Anthracene	ND	0.50	ug/L
Benzo(a)anthracene	ND	0.65	ug/L
Benzo(a)pyrene	ND	1.2	ug/L
Benzo(b)fluoranthene	ND	0.90	ug/L
Benzo(ghi)perylene	ND	1.0	ug/L
Benzo(k)fluoranthene	ND	0.85	ug/L
Chrysene	ND	1.0	ug/L
Dibenzo(a,h)anthracene	ND	1.5	ug/L
Fluoranthene	ND	1.0	ug/L
Fluorene	ND	1.0	ug/L
Indeno(1,2,3-cd)pyrene	ND	2.2	ug/L
Naphthalene	**180**	**5.0**	**ug/L**
Phenanthrene	ND	1.0	ug/L
Pyrene	ND	1.0	ug/L

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Terphenyl-d14	0.0 DIL,*	(25 - 157)

NOTE(S):

DIL The concentration is estimated or not reported due to dilution or the presence of interfering analytes.

* Surrogate recovery is outside stated control limits.

2C

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJMP-B

HPLC

Lot-Sample #...: D8L050133-002 Work Order #...: CP1X8102 Matrix.........: WG
Date Sampled...: 12/03/98 10:10 Date Received..: 12/05/98
Prep Date.......: 12/09/98 Analysis Date..: 01/12/99
Prep Batch #...: 8343154 Analysis Time..: 16:42
Dilution Factor: 5

Method.........: SW846 8310

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Acenaphthene	ND	5.0	ug/L
Acenaphthylene	ND	5.0	ug/L
Anthracene	ND	0.50	ug/L
Benzo(a)anthracene	ND	0.65	ug/L
Benzo(a)pyrene	ND	1.2	ug/L
Benzo(b)fluoranthene	ND	0.90	ug/L
Benzo(ghi)perylene	ND	1.0	ug/L
Benzo(k)fluoranthene	ND	0.85	ug/L
Chrysene	ND	1.0	ug/L
Dibenzo(a,h)anthracene	ND	1.5	ug/L
Fluoranthene	ND	1.0	ug/L
Fluorene	ND	1.0	ug/L
Indeno(1,2,3-cd)pyrene	ND	2.2	ug/L
Naphthalene	**190**	**5.0**	**ug/L**
Phenanthrene	ND	1.0	ug/L
Pyrene	ND	1.0	ug/L

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Terphenyl-d14	0.0 DIL,*	(25 - 157)

NOTE(S):

DIL The concentration is estimated or not reported due to dilution or the presence of interfering analytes.

* Surrogate recovery is outside stated control limits.

1C

PARSONS ENGINEERING SCIENCE, INC.

Client Sample ID: 98SJMP-B

HPLC

Lot-Sample #...: D8L050133-002	Work Order #...: CP1X8105	Matrix.........: WG
Date Sampled...: 12/03/98 10:10	Date Received..: 12/05/98	
Prep Date......: 12/09/98	Analysis Date..: 01/12/99	
Prep Batch #...: 8343154	Analysis Time..: 16:42	
Dilution Factor: 5		
	Method.........: SW846 8310	

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Acenaphthene	ND	5.0	ug/L
Acenaphthylene	ND	5.0	ug/L
Anthracene	ND	0.50	ug/L
Benzo(a)anthracene	ND	0.65	ug/L
Benzo(a)pyrene	ND	1.2	ug/L
Benzo(b)fluoranthene	ND	0.90	ug/L
Benzo(ghi)perylene	ND	1.0	ug/L
Benzo(k)fluoranthene	ND	0.85	ug/L
Chrysene	ND	1.0	ug/L
Dibenzo(a,h)anthracene	ND	1.5	ug/L
Fluoranthene	ND	1.0	ug/L
Fluorene	ND	1.0	ug/L
Indeno(1,2,3-cd)pyrene	ND	2.2	ug/L
Naphthalene	**170**	**5.0**	**ug/L**
Phenanthrene	ND	1.0	ug/L
Pyrene	ND	1.0	ug/L

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Terphenyl-d14	0.0 DIL,*	(25 - 157)

NOTE(S):

DIL The concentration is estimated or not reported due to dilution or the presence of interfering analytes.

* Surrogate recovery is outside stated control limits.

2C

Laboratory Non-Conformance Memo (NCM)

8744205

Quanterra Environmental Services

NCM Log Number: 15695

QUA-4187 D8L050133-01, -02

Project ID/Client: D8L090209-03, D8L100136-01 } PARSONS

Sample Numbers	NCM Initiated by/Date	Project Manager
	IL 1-15-99	LARIVIERE

Team: IL/BNA

Tests: 625

Analytical Area (check appropriate box)

- [ ] Sample control
- [ ] Organic preparation
- [ ] Inorganic preparation
- [ ] GC
- [ ] HPLC
- [x] GC/MS
- [ ] Wet chemistry
- [ ] Metals
- [ ] Reporting
- [ ] Data review
- [ ] Radiochemistry
- [ ] ______

Non-Conformance (check appropriate box) To be completed by analyst

Holding Time Violation (exceeded by ________ days)

Category I: Laboratory Independent

- [ ] 1. Holding time expired in transit
- [ ] 2. Sample received > 48 hours or 1/2 holding time has expired
- [ ] 3. Test added by client after expiration

Category II: Laboratory Dependent

- [ ] 4. Instrument failure
- [ ] 5. Analyst error
- [ ] 6. Log-in error
- [ ] 7. Miscommunication
- [ ] 8. Other (explanation required)

Category III: Analysis Reruns (QA/QC)

- [ ] 9. Surrogates
- [ ] 10. Internal standards
- [ ] 11. Spike recoveries
- [ ] 12. Blank contamination

Category IV: Analysis Reruns (Confirmation)

- [ ] 13. Second column
- [ ] 14. Contamination check
- [ ] 15. Confirmation of matrix effects
- [ ] 16. Other (explanation required) ________

Quality Assurance/Quality Control

- [x] 17. QC data reported outside of controls
- [ ] 18. Incorrect procedure used
- [ ] 19. SOP intentionally modified with QA and tech approval
- [ ] 20. Invalid instrument calibration
- [ ] 21. Received insuffient sample for proper analysis

Incorrect or Incomplete Client Deliverable

- [ ] 22. Hardcopy deliverable error
- [ ] 23. Electronic deliverable error

Reported Detection Limits Elevated Due to:

- [ ] 24. Sample matrix: Does not include high analyte content
- [ ] 25. Insufficient sample volume
- [ ] 26. Other (explanation required)

Miscellaneous

- [ ] 27. Instrument Tag-out
- [x] 28. Other (explanation required)

EXPIRED LCS/MS STANDARD (V11292) USED BECAUSE LAB RAN OUT OF STANDARD AND THE SAMPLES WOULD HAVE EXPIRED PRIOR TO RECEIPT OF A REPLACEMENT STANDARD.

Notification (check appropriate box) To be completed by project manager

- [ ] Required
- [ ] Not Required

Client notified by - Name: ________ Date: ________

- [ ] In writing
- [ ] By telephone
- [ ] By facsimile
- [ ] Other (explain) ________

Client name and response:

- [ ] Process "as is"
- [ ] On hold until ________
- [ ] Re-sample
- [ ] Other (explain) ________

Project manager signature: ________ Date: ________

[redacted]

Laboratory Non-Conformance Memo (NCM)

Quanterra
Environmental Services

NCM Log Number 15695

QUA-4187

Corrective Action (To be completed and reviewed by all associates involved)

Problem Description/Root Cause

SEE ATTACHMENT

Author's initials and date [initials] 1-15-99

Corrective Actions (Short Term)

THE SAMPLES HAVE EXPIRED. NOTIFY CLIENT PRIOR TO TAKING CORRECTIVE ACTION.

Author's initials and date [initials] 1-15-99

Corrective Actions to Prevent Reoccurence (Long Term)

ENSURE THAT STANDARDS ARE REPLACED PRIOR TO DEPLETION.

Corrective Action approved by (Supervisor/Group Leader) and date [initials] 1-15-99

Additional Comments

Corrective Action to be completed by (if other than Supervisor/Group Leader)

Date Corrective Action is to be completed

Quality Assurance Review (To be completed by a QA associate)

Log ID ☐ Anomaly ☐ Deficiency ☐ Notified Ops/Sys Manager (Initials)

☐ Further action required

☐ Further action assigned to

QA signature

Date

Corrective Action Verification (To be completed by a QA associate)

☐ Verification not required or requested ☐ Verified/CA completed on ______ by ______

☐ Cannot verifiy (specify reason)

Verified by

Date

Nonconformance Memo Closure

QA signature

Date

The office of Quality Assurance maintains a copy of this NCM indicating its final status.

[redacted]

Laboratory Non-Conformance Memo (NCM)

Quanterra Environmental Services

QUA-4187

NCM Log Number 15893

...ect ID/Client	Sample Numbers	NCM Initiated by/Date	Project Manager
XL050133	01, MS/SD, 02	AC 1/14	E. LARIVIERE

...Team

Tests
8310

Analytical Area (check appropriate box)

- [ ] Sample control
- [ ] Organic preparation
- [ ] Inorganic preparation
- [ ] GC
- [X] HPLC
- [ ] GC/MS
- [ ] Wet chemistry
- [ ] Metals
- [ ] Reporting
- [ ] Data review
- [ ] Radiochemistry
- [ ] ______

Non-Conformance (check appropriate box) To be completed by analyst

Holding Time Violation (exceeded by ______ days)

Category I: Laboratory Independent

- [ ] 1. Holding time expired in transit
- [ ] 2. Sample received > 48 hours or 1/2 holding time has expired
- [ ] 3. Test added by client after expiration

Category II: Laboratory Dependent

- [ ] 4. Instrument failure
- [ ] 5. Analyst error
- [ ] 6. Log-in error
- [ ] 7. Miscommunication
- [ ] Other (explanation required)

...egory III: Analysis Reruns (QA/QC)

- [ ] 9. Surrogates
- [ ] 10. Internal standards
- [ ] 11. Spike recoveries
- [ ] 12. Blank contamination

Category IV: Analysis Reruns (Confirmation)

- [ ] 13. Second column
- [ ] 14. Contamination check
- [ ] 15. Confirmation of matrix effects
- [ ] 16. Other (explanation required) ______

Quality Assurance/Quality Control

- [X] 17. QC data reported outside of controls
- [ ] 18. Incorrect procedure used
- [ ] 19. SOP intentionally modified with QA and tech approval
- [ ] 20. Invalid instrument calibration
- [ ] 21. Received insuffient sample for proper analysis

Incorrect or Incomplete Client Deliverable

- [ ] 22. Hardcopy deliverable error
- [ ] 23. Electronic deliverable error

Reported Detection Limits Elevated Due to:

- [ ] 24. Sample matrix: Does not include high analyte content
- [ ] 25. Insufficient sample volume
- [ ] 26. Other (explanation required)

Miscellaneous

- [ ] 27. Instrument Tag-out
- [ ] 28. Other (explanation required) ______

Notification (check appropriate box) To be completed by project manager

- [ ] Required
- [X] Not Required

...ent notified by - Name | Date | [ ] In writing [ ] By telephone [ ] By facsimile [ ] Other (explain) ______

...ame and response | [ ] Process "as is" [ ] On hold until ______ [ ] Re-sample [ ] Other (explain) ______

Project manager signature: Ellen LaRiviere

Date 1/14/99

[redacted]

aboratory Non-Conformance
lemo (NCM)

Quanterra Environmental Services

NCM Log Number 15893

QUA-4187

rective Action (To be completed and reviewed by all associates involved)

em Description/Root Cause

LCS/LCSD : % rec. Dibenz(a,h)anthracene is 121% & 122% rec.
limits are 35-103%.
MSQC is diluted out

Author's initials and date AC 1/14/99

Corrective Actions (Short Term)

NONE

Author's initials and date AC 1/14/99

Corrective Actions to Prevent Reoccurence (Long Term)

NONE

Corrective Action approved by (Supervisor/Group Leader) and date 01/14/99

Additional Comments

There are no hits for this compound in any of the samples.

Corrective Action to be completed by (if other than Supervisor/Group Leader)

Date Corrective Action is to be completed

Quality Assurance Review (To be completed by a QA associate)

Log ID

☐ Anomaly ☒ Deficiency ☐ Notified Ops/Sys Manager (Initials)

☐ Further action required

☐ Further action assigned to

QA signature

Date 1/15/99

Corrective Action Verification (To be completed by a QA associate)

☐ Verification not required or requested ☐ Verified/CA completed on ________ by ________

☐ Cannot verifiy (specify reason)

Verified by

Date

Nonconformance Memo Closure

QA signature

Date 1/15/99

The office of Quality Assurance maintains a copy of this NCM indicating its final status.

[redacted]

Chain Custody Record

Quanterra

QUA-4124 0797

Client	Project Manager	Date	Chain of Custody Number
Parsons Engineering Science, Inc	John Hicks	11/4/98	20253
Address	**Telephone Number (Area Code)/Fax Number**	**Lab Number**	**Page**
1700 Broadway Suite 900	303-831-8100 fax -8205	D8L050133	Page 1 of 1

City	State	Zip Code	Site Contact	Lab Contact
Denver	CO	80290	Tom Drgco	John Mitchell

Project Name: AFCEE RBCA Investigation

Carrier/Waybill Number:

Contract/Purchase Order/Quote No.: 731854.05000

	Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Matrix: Aqueous	Sed.	Soil		Containers & Preservatives: Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/NaOH	Analysis: 8310 SVOC	8310 SVOC MS	8310 SVOC MSD	625 SVOC	Special Instructions/ Conditions of Receipt: Quantity
001	98SJMW-4	12/3/98	0930	X				X						X				2-1L Ambers
001MS	98SJMW-4	12/3/98	0930	X				X							X			2-1L Ambers
001MSD	98SJMW-4	12/3/98	0930	X				X								X		2-1L Ambers
001	98SJMW-4	12/4/98	0900	X				X									X	2-1L Ambers
	TRIP BLANK																	3-VOAs
	TEMPERATURE BLANK																	1-500mL Poly

Possible Hazard Identification: ☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☒ Unknown

Sample Disposal: ☐ Return To Client ☐ Disposal By Lab ☒ Archive For 3 Months (A fee may be assessed if samples are retained longer than 3 months)

Turn Around Time Required: ☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☐ 14 Days ☐ 21 Days ☐ Other

QC Requirements (Specify):

	Date	Time		Date	Time
1. Relinquished By: Tom Drgco	12/4/98	1500	1. Received By	12-5-98	515
2. Relinquished By			2. Received By		
3. Relinquished By			3. Received By		

Comments

48

DISTRIBUTION: WHITE - Stays with the Sample; CANARY - Returned to Client with Report; PINK - Field Copy

[redacted]

Chain of Custody Record

Quanterra

QUA-4124 0797

Client	Parsons Engineering Science, Inc.
Address	1700 Broadway Suite 900
City	Denver
State	CO
Zip Code	80290
Project Name	AFCEE RBCA Investigation
Contract/Purchase Order/Quote No.	
Project Manager	John Hicks
Telephone Number (Area Code)/Fax Number	303-831-8100 fax - 8208
Site Contact	Tom Dragoo
Lab Contact	John Mitchell
Carrier/Waybill Number	
Date	12/4/98
Lab Number	
Chain of Custody Number	20254
Page	1 of 1

Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Matrix: Aqueous	Sed.	Soil	Containers & Preservatives: Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/NaOH	Analysis (Attach list if more space is needed): 625 SVOC	625 SVOC MS	625 SVOC MSD	8310 SVOC	Special Instructions/Conditions of Receipt: Quantity
-002 98SJMP-B	12/3/98	1010	X			X						X				2- 1L Ambers
-002MS 98SJMP-B	12/3/98	1010	X			X							X			2- 1L Ambers
-002SD 98SJMP-B	12/3/98	1010	X			X								X		2- 1L Ambers
-002 98SJMP-B	12/3/98	1010	X			X									X	2- 1L Ambers
TEMPERATURE BLANK																1 - Voa
TRIP BLANK																3 - Voas

Possible Hazard Identification
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☒ Unknown

Sample Disposal
☐ Return To Client ☐ Disposal By Lab ☒ Archive For 3 Months (A fee may be assessed if samples are retained longer than 3 months)

Turn Around Time Required
☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☐ 14 Days ☐ 21 Days ☐ Other

QC Requirements (Specify)

	Date	Time		Date	Time
1. Relinquished By: Tom Dragoo	12/4/98	1500	1. Received By	12-5-98	815
2. Relinquished By			2. Received By		
3. Relinquished By			3. Received By		

Comments

49

DISTRIBUTIO. HITE - Stays with the Sample; CANARY - Returned to Client with Report; PINK - Field Copy

Lot #: D8L050133 Date/Time Received: 12-5-98 @ 815

Company Name & Sampling Site: Parsons

*Cooler #(s):

Temperatures: 2.5 2.8

Unpacking & Labeling Check Points:

N/A	Yes	No		Initials
	☐	☐	1. Radiation checked, record if reading > 0.5 mR/hr. (______ mR/hr)	ND
	☑	☐	2. Cooler seals intact.	
	☑	☐	3. Chain of custody present.	
	☐	☑	4. Bottles broken and/or are leaking, comment if yes.	

PHOTOGRAPH BROKEN BOTTLES

N/A	Yes	No		Initials
	☐	☐	5. Containers labeled, comment if no.	
	☐	☐	6. pH of all samples checked and meet requirements, note exceptions.	
	☐	☐	7. Chain of custody includes "received by" and "relinquished" by signatures, dates, and times.	
	☐	☑	8. Receipt date(s) > 48 hours past the collection date(s)? If yes, notify PA/PM.	
	☑	☐	9. Chain of custody agrees with bottle count, comment if no.	
	☑	☐	10. Chain of custody agrees with labels, comment if no.	
☐	☐	☐	11. VOA samples filled completely, comment if no.	
	☐	☐	12. VOA bottles preserved, check for labels.	
	☐	☐	13. Did samples require preservation with sodium thiosulfate?	
☐	☐	☑	14. If yes to #12, did the samples contain residual chlorine?	
☐	☐	☐	15. Sediment present in "D," dissolved, bottles.	
	☐	☑	16. Are analyses with short holding times requested?	
☐	☑	☐	17. Is extra sample volume provided for MS, MSD or matrix duplicates?	
	☐	☑	18. Multiphase samples present? If yes, comment below.	
	☐	☐	19. Any subsampling for volatiles? If yes, list samples.	

* only 2 bottles for the MS, MSD not 4 ~~[illegible]~~

PHOTOGRAPH MULTIPHASE SAMPLES

N/A	Yes	No		Initials
☐	☐	☐	20. Clear picture taken, labeled, and stapled to project folder.	
☐	☐	☐	21. Subcontract COC signed and sent with samples to bottle prep?	
	☐	☐	22. Was sample labeling double checked?	

Comments: Include action taken to resolve discrepancies/problems. Include a hard copy of e-mail or use extra paper if more space is needed.

Initials:

Revision 4 6/26/98

[illegible]SAMPLE RECEIVINGSAMPCHECK.DOC

APPENDIX B

DATA FROM PREVIOUS INVESTIGATIONS

COMPREHENSIVE SITE ASSESSMENT

FILE # 258

JVDe

DEPARTMENT OF THE AIR FORCE
4TH FIGHTER WING (ACC)
SEYMOUR JOHNSON AIR FORCE BASE NC

30 OCT 1997

4th Civil Engineer Squadron/CC
1095 Peterson Avenue
Seymour Johnson AFB NC 27531

NCDENR
Attention: Ms. Lynn Daniel
Groundwater Section
1424 Carolina Ave.
Washington, NC 27889

Dear Ms. Daniel,

A Notice of Violation was issued to Seymour Johnson AFB on February 29, 1996. The violation was issued due to a release from underground piping associated with an airport hydrant fuel distribution system. Releases from the system are subject to the release response and corrective actions requirements of Title 15A NCAC, Chapter 2N, Section .0700.

However, North Carolina Senate Bill 1317 suspended the requirements to cleanup contamination from low priority sites. A Comprehensive Site Assessment (CSA) was submitted to the Washington Regional Office in July, 1996. The CSA contains information necessary to prioritize the site. We believe the information supplied justifies a site ranking of "E" (low priority) because no supply wells are within 1500 feet and all persons within 1500 feet are served by an existing public water supply. We therefore, request a ranking of low priority and the provisions of SB 1317 be applied to this site.

If there are further questions, my point of contact for this matter is Mr. Dean Chastain, P.E., 4 CES/CEV, at telephone 919.736.6690.

Sincerely

/s/

HENRY F. LABRECQUE, JR., P.E.
Deputy Base Civil Engineer

AFD: T:\Library\Comp2\WQ\4522Rank.doc\th

COORDINATION	
Sec	DH 10/28/97
CEV	JVDe 10/28/97
CEV	DRA 10/29/97
CD	
CC	

0 2 DEC 1997

State of North Carolina
Department of Environment
and Natural Resources
Washington Regional Office

James B. Hunt, Jr., Governor
Wayne McDevitt, Secretary

CEV

NCDENR
NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

**DIVISION OF WATER QUALITY
GROUNDWATER SECTION**

November 25, 1997

CERTIFIED MAIL Z 399 273 260
RETURN RECEIPT REQUESTED

Lt. Col. Quincy D. Purvis, Commander
4th Civil Engineer Squadron/CC
1095 Peterson Avenue
Seymour Johnson AFB, NC 27531

SUBJECT: **NOTICE OF REGULATORY REQUIREMENTS of 15A NCAC 2N**
Building 4522
Seymour Johnson AFB, North Carolina
Wayne County
Groundwater Incident Number # 15135, Site Ranking 70/E

Dear Colonel Purvis:

Information received by this office on February 14, 1996 confirms a product release from an underground storage tank system at the above referenced location. On December 14, 1995, a release of approximately 5,000 gallons of JP-8 fuel flooded a valve pit associated with underground piping and underground storage tanks, which are a part of the airport hydrant fuel distribution system on the base. Records indicate that you are the owner and/or operator of this underground storage tank system. This letter is a standard notice explaining the actions you must take as a result of the release in accordance with North Carolina laws. This Notice of Regulatory Requirements supersedes the Notice of Violation sent dated February 29, 1996. The Groundwater Section of the Division of Water Quality, administers the State's rules for underground storage tanks and the required release response for petroleum releases. Those rules are located in Title 15A, Subchapter 2N of the North Carolina Administrative Code (NCAC).

The Division of Water Quality is required to rank sites as either "AB" or "CDE". AB sites are of the highest priority and require the most work. **Your site has been tentatively classified as a Class CDE.** The classification was determined based largely upon information provided by you or your consultant and is subject to revision as additional information is received. Listed below are general descriptions of action you must take to comply with State rules (2N .0702-.0705 are attached). For a detailed description of your requirements please refer to the enclosed rules.

SEP 04 '98 12:37PM 4 CES/CEV STATE NC P.3/7

1) If you have not already done so, you must take immediate action to prevent any further release of the regulated substance into the environment and identify and mitigate any fire, explosion, and vapor hazards. (Title 15A NCAC 2N .0702) This requirement has been satisfied according to the information within the Comprehensive Site Assessment dated July 1996.

2) Undertake initial abatement measures, perform a site check, and if free product is discovered, begin recovery within 14 days thereafter. A report of the measures you have taken to comply with this rule must be received by the Washington Regional Office at the letterhead address no later than 20 days from the receipt of this letter. (Title 15A NCAC 2N .0703) This requirement has been satisfied according to the information within the Comprehensive Site Assessment dated July 1996.

3) Assemble information about the nature and quantity of the release and about the site and the surrounding area. A report of this information must be received by the Washington Regional Office by no later than 45 days from the receipt of this letter. (Title 15A NCAC 2N .0704) This requirement has been satisfied according to the information within the Comprehensive Site Assessment dated July 1996.

4) If free product is discovered during the initial site check (#2 above), a report describing the free product removal measures being undertaken must be received by the Washington Regional Office by no later than 45 days from the receipt of this letter. (Title 15A NCAC 2N .0705)

If requested, the Washington Regional Office may allow an alternate compliance schedule for the release response rules and may allow certain reports to be combined. In order for such an alternate compliance schedule to be considered, you must contact the Washington Regional Office immediately and follow-up in writing with a proposed schedule. An alternate compliance schedule cannot be granted for the 20 day initial abatement report (#2 above).

Your prompt attention to the items described herein is required. Failure to comply with the State's rules may result in the assessment of civil penalties and/or the use of other enforcement mechanisms available to the State. Each day that a violation continues may be considered a separate violation.

SEP 04 '98 12:32PM 4 CES/CEV SJAFB NC P.4/7

If you believe you are not the responsible party notify the Groundwater Section within 15 days of receipt of this letter. If you have any questions regarding the actions that must be taken or the rules mentioned in this letter, please contact Lynn C. Daniel, of the Washington Regional Office, at the letterhead address and/or telephone number. If you have any questions regarding trust fund eligibility or reimbursement, please contact the Groundwater Section at (919) 733-8486.

Sincerely,

Jim Mulligan

Jim Mulligan
Regional Supervisor

JM:lcd

Enclosures

cc: Washington Regional Office

SEP 04 '98 12:38PM 4 CES/CEV SJAFB NC P.5/7

State of North Carolina
Department of Environment
and Natural Resources
Washington Regional Office

James B. Hunt, Jr., Governor
Wayne McDevitt, Secretary

NCDENR
NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

DIVISION OF WATER QUALITY
GROUNDWATER SECTION
November 25, 1997

Lt. Col. Quincy D. Purvis, Commander
4th Civil Engineer Squadron /CC
1095 Peterson Avenue
Seymour Johnson AFB, NC 27531

RE: Site Priority Rank Notice
Building 4522
Seymour Johnson AFB, North Carolina - Wayne County
Groundwater Incident Number #15135, Site Ranking 70/E

Dear Colonel Purvis:

On November 19, 1997, the Groundwater Section of the Washington Regional Office received the Comprehensive Site Assessment dated July 1996, prepared by Parsons Engineering Science, Incorporated. Our review of the subject document indicates that you have satisfied the requirements of North Carolina Administrative Code 15A, Subchapter 2N (NCAC 15A 2N) Criteria and Standards Applicable to Underground Storage Tanks, Paragraphs .0601 through .0604 and .0701 through .0704 (40 CFR 280.50 through 280.53 and 280.60 through 280.63, respectively).

In accordance with Senate Bill 1317, the requirement to perform additional assessment and remediation at low priority sites (CDE) is temporarily suspended. By this letter, we hereby notify you that your site has been given a tentative priority ranking score of 70/E, which is considered a low priority. However, your efforts to recover free product must continue (also in accordance with Senate Bill 1317) until it has been removed.

The Department has the latitude to re-rank sites if situations change that may pose an imminent danger to public health or the environment. Therefore, if you are aware of any information that could change the rank of your site, please contact the Washington Regional Office.

252-

Should you have any questions or require additional information, please feel free to contact me at (919) 946-6481, extension 282.

Sincerely,

Lynn C. Daniel
Groundwater Section

cc: WaRO

PARSONS ENGINEERING SCIENCE, INC.

401 Harrison Oaks Boulevard, Suite 210 • Cary, North Carolina 27513 • (919) 677-0080 • Fax. (919) 677-0118

July 24, 1996

Ms. Lynn C. Daniel
North Carolina Department of Environment, Health, and Natural Resources
Division of Environmental Management
Washington Regional Office
1424 Carolina Avenue
Washington, North Carolina 27889

Subject: Building 4522, Seymour Johnson AFB, Goldsboro, NC - Comprehensive Site Assessment Report

Dear Ms. Daniel:

Enclosed is the Comprehensive Site Assessment (CSA) for Building 4522 located at Seymour Johnson AFB, Goldsboro, North Carolina. This CSA is being submitted to your office on behalf of Seymour Johnson Air Force Base. If you have any questions or concerns regarding this CSA, please contact us at (919) 677-0080.

Sincerely,

PARSONS ENGINEERING
SCIENCE, INC.

Jefferson B Prather

Jefferson B. Prather, P.E., C.I.H.
Project Manager

TCR:par

ENCLOSURE

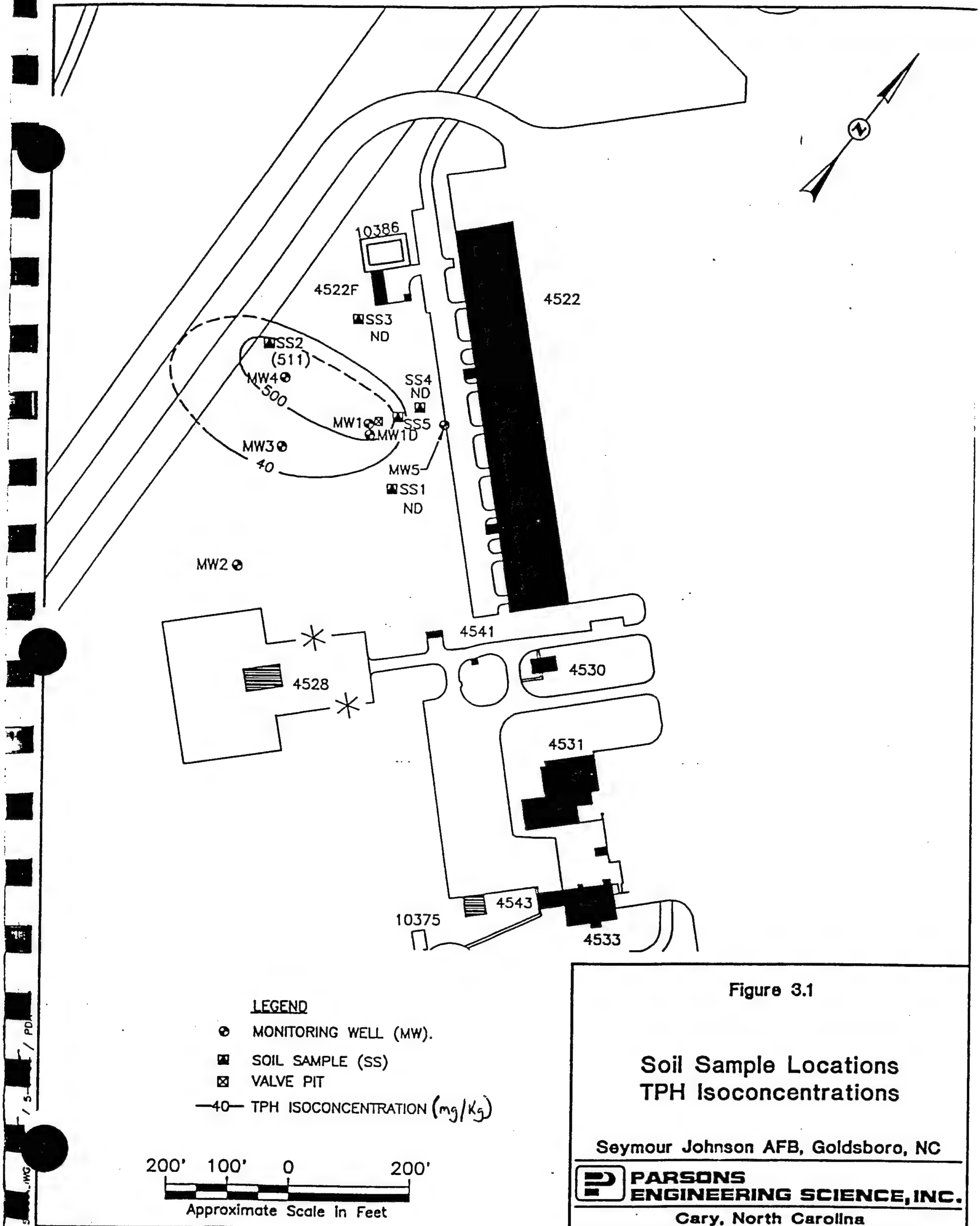
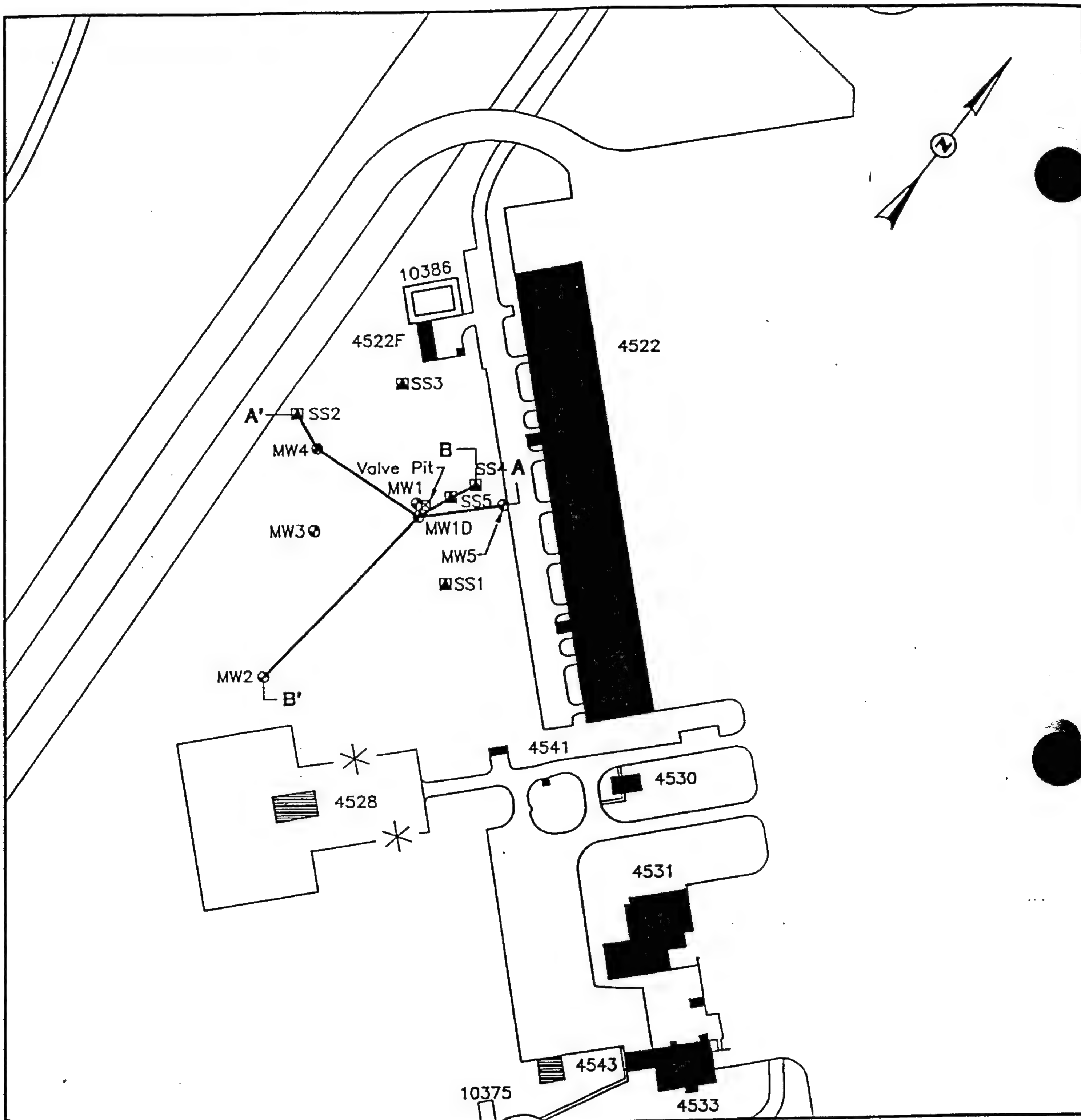


Figure 3.1

Soil Sample Locations
TPH Isoconcentrations

Seymour Johnson AFB, Goldsboro, NC

PARSONS ENGINEERING SCIENCE, INC.
Cary, North Carolina



LEGEND

- MONITORING WELL (MW).
- VALVE PIT.
- Soil Boring Locations (SS–1).

200' 100' 0 200'

Approximate Scale in Feet

Figure 4.1

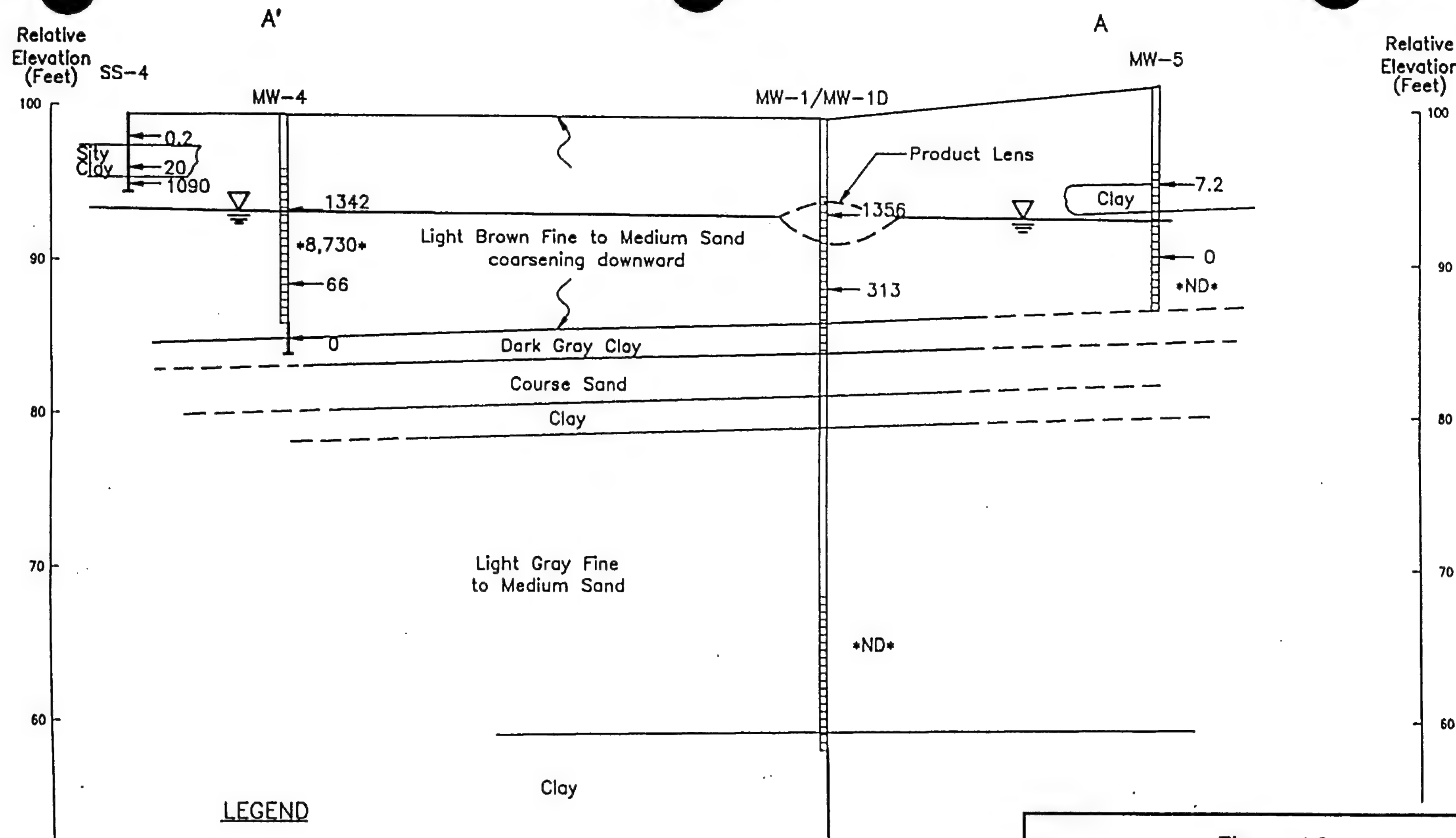
Map View Showing Cross Sections

Seymour Johnson AFB, NC
Goldsboro, North Carolina

PARSONS ENGINEERING SCIENCE, INC.
Cary, North Carolina

SJ041.DWG / 1=1 / 5-2-96 / PDA

SJ041.DWG / 5-14-96 / PDA



LEGEND

	Monitoring point screen interval.
	Water table.
2.2	PID reading (ppm).
(BQL)	TPH gasoline range result. (Below Quantitation Limit)
[BQL]	TPH diesel/kerosene range result. [Below Quantitation Limit]
ND	Total concentration BETX compounds (µg/L).
ND	None detected.

50' 25' 0

10' 5' 0

Figure 4.2

CROSS SECTION A-A'
BUILDING 4522 SITE

Seymour Johnson AFB, NC
Goldsboro, North Carolina

PARSONS ENGINEERING SCIENCE, INC.
Cary, North Carolina

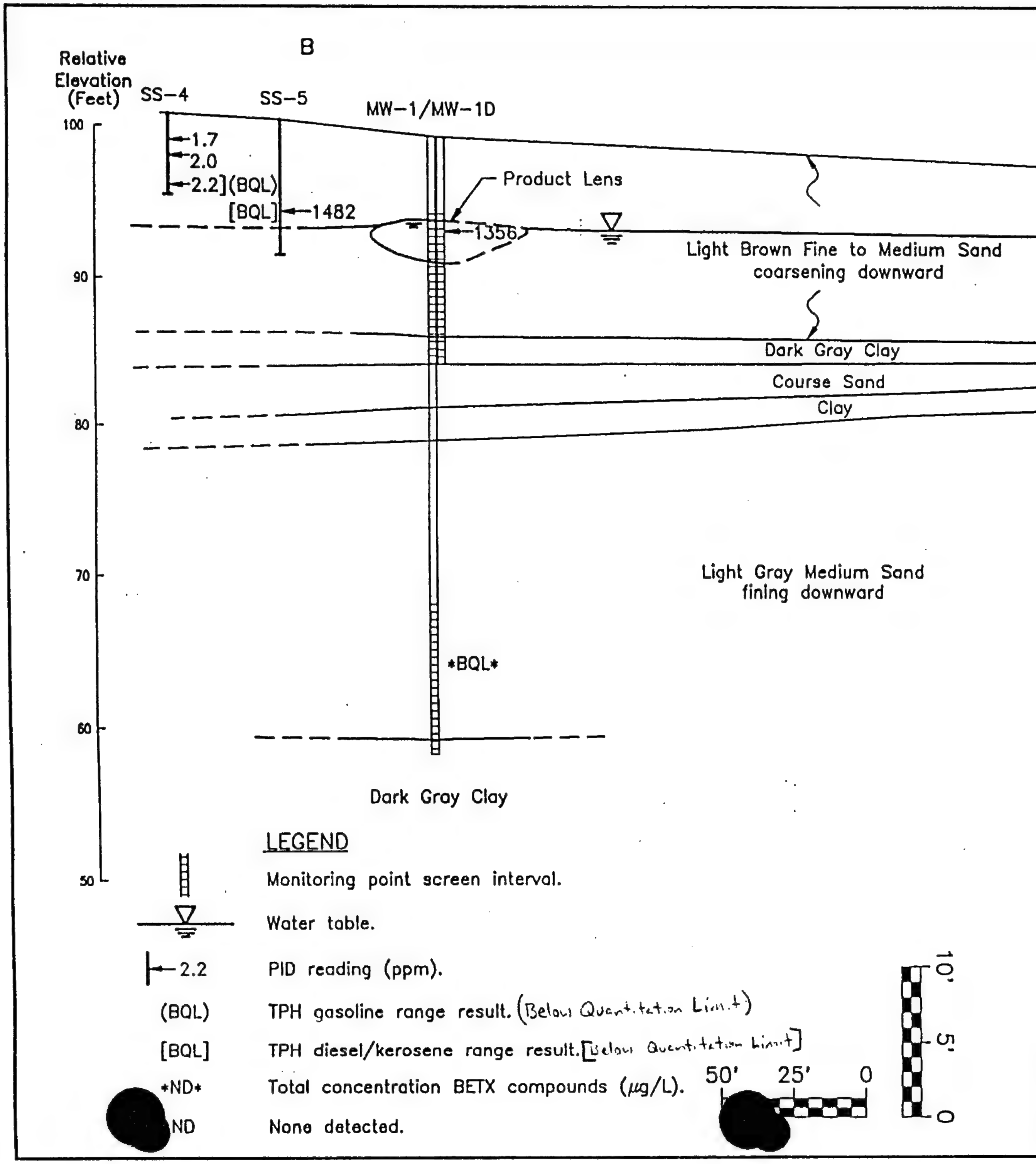


Figure 4.3

CROSS SECTION B-B'
BUILDING 4522 SITE

Seymour Johnson AFB, NC
Goldsboro, North Carolina

PARSONS ENGINEERING S[illegible]NCE, INC.
Cary, North Ca[illegible]

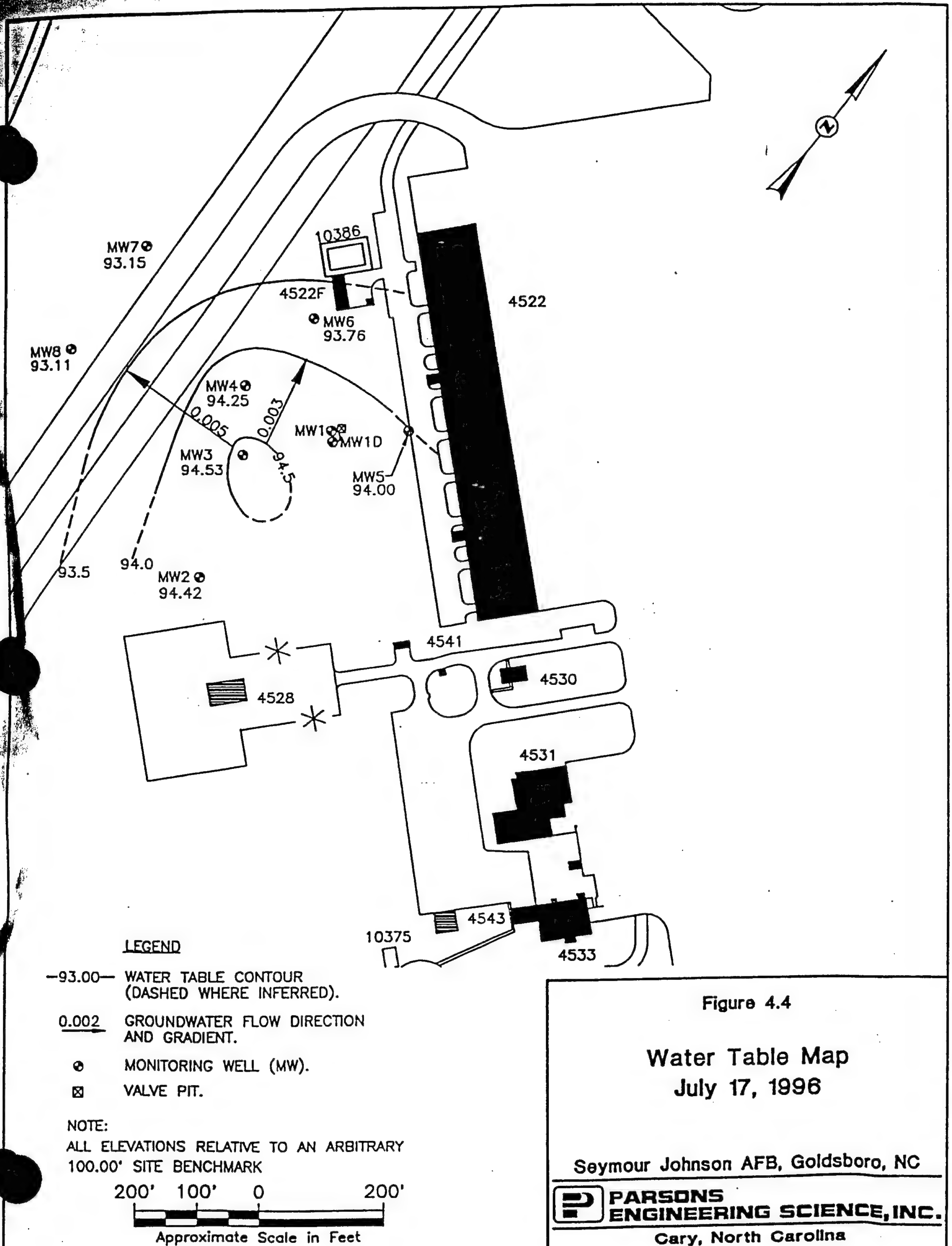


Figure 4.4

Water Table Map
July 17, 1996

Seymour Johnson AFB, Goldsboro, NC

PARSONS ENGINEERING SCIENCE, INC.
Cary, North Carolina

TABLE 4.1
PID SOIL SCREENING AND TPH ANALYTICAL RESULTS
BUILDING 4522
SEYMOUR JOHNSON AIR FORCE BASE
APRIL 1996

			TPH Results (mg/Kg)	
Sample No	Depth (ft)	Result (ppm)	5030	3550
MW-1	5-7	1356.0	NA	NA
MW-1	10-12	313.0	NA	NA
MW-2	5-7	0.8	NA	NA
MW-2	10-12	0.0	NA	NA
MW-3	5-7	519.0	NA	NA
MW-3	10-12	0.0	NA	NA
MW-4	5-7	1342.0	NA	NA
MW-4	10-12	66.0	NA	NA
MW-4	13.5-15.5	0.0	NA	NA
MW-5	5-7	7.2	NA	NA
SS-1	1-2	3.8	NA	NA
SS-1	3-4	0.7	NA	NA
SS-1	4-5	2.3	BQL	BQL
SS-2	1-2	0.2	NA	NA
SS-2	3-4	20.0	NA	NA
SS-2	4-5	1090.0	BQL	511
SS-3	1.5-2.5	1.6	NA	NA
SS-3	3-4	2.5	NA	NA
SS-3	5-6	1.8	BQL	BQL
SS-4	1-2	1.7	NA	NA
SS-4	2-3	2.0	NA	NA
SS-4	4-5	2.2	BQL	BQL

Results in parts per million.
Total Petroleum Hydrocarbon (TPH) results in mg/Kg.
TPH quantified using modified California method 8015 with extraction method 5030 (gasoline range) and 3550 (diesel/kerosene range)
Depths in feet BLS.
NA = Not Analysed.

TABLE 4.2
GROUNDWATER ANALYTICAL LABORATORY RESULTS
BUILDING 4522
SEYMOUR JOHNSON AIR FORCE BASE
APRIL 18, and JULY 14, 1996

Well No.	Benzene[1]	Toluene[1]	Ethylbenzene[1]	Xylenes[1]	Naphthalene[2]	Chloroform	Lead[3]
MW-1	NSP						
MW-1D	<1.0	<1.0	<1.0	<2.0	<10	1	21.6
MW-2	<1.0	<1.0	<1.0	<2.0	<10	<25	15.8
MW-3	<1.0	<1.0	23	55	13	<25	13
MW-4	1,400	3,700	730	2,900	120	<25	18.6
MW-5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	18.4
Duplicate	<1.0	<1.0	10	29	13	<1.0	14.7
MW-6	460	<5.0	<5.0	<10.0	12	<1.0	NA
MW-7	2	<1.0	1	<2.0	<1.0	<1.0	NA
MW-8	<1.0	2	<1.0	<2.0	<1.0	<1.0	NA
NCAC 2L	1	1000	29	530	21	0.19	15

Results in µg/L.

[1]Samples analyzed by EPA Method 602.

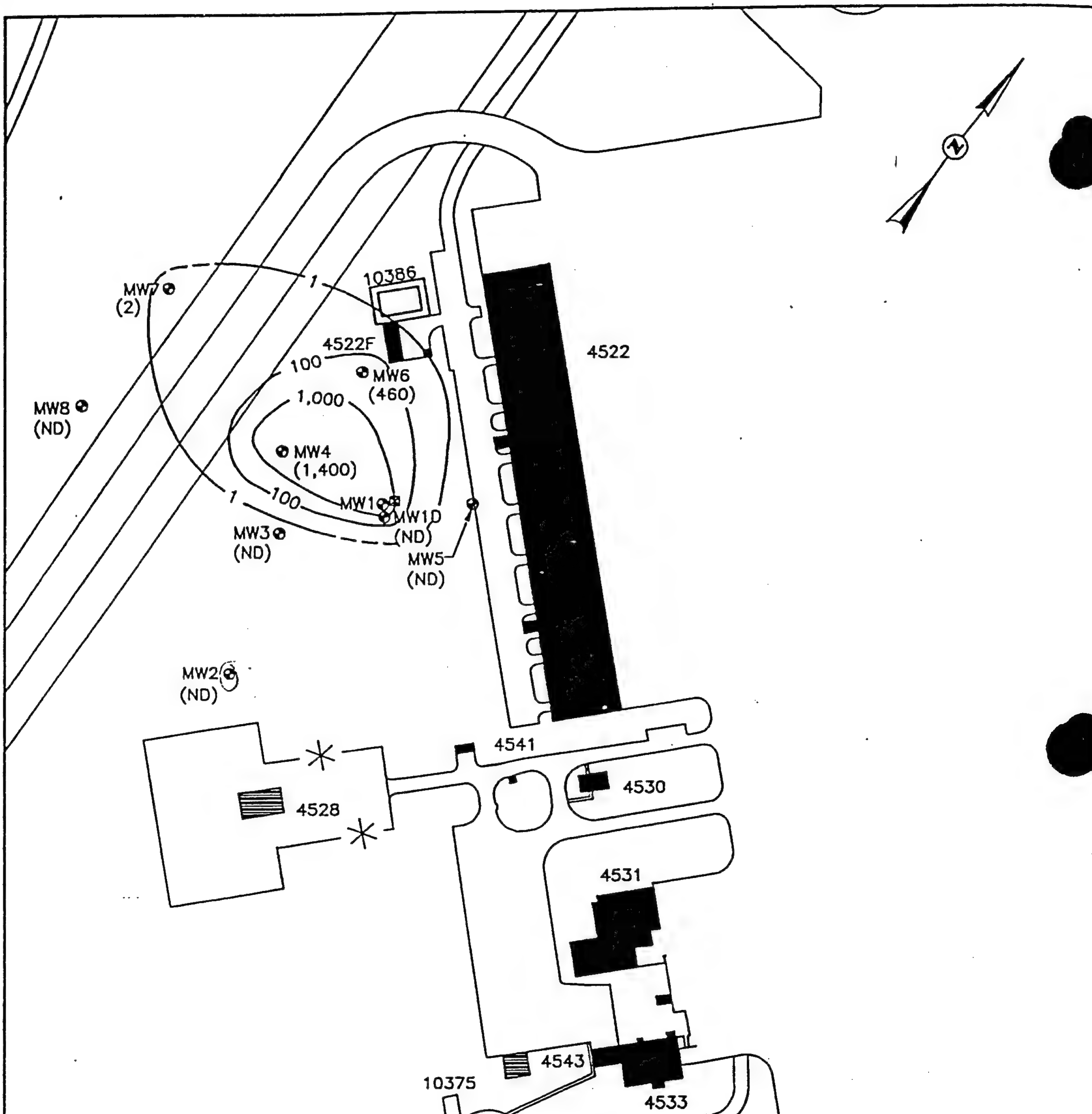
[2]Samples analyzed by EPA Method 625.

[3]Samples analyzed by EPA Method 239.2 by 3030C.

NS - The standard for compounds not included in the 15A NCAC 2L .0202 list is the method detection limit.

NSP - Not sampled due to presence of free phase product in the well.

NA - Not analyzed.



NOTE: MW-1D NOT USED TO CONSTRUCT MAP.

LEGEND

- MONITORING WELL (MW)
- VALVE PIT
- (ND) NONE DETECTED
- (1,400) COMPOUND CONCENTRATIONS (ug/L)

200' 100' 0 200'

Approximate Scale in Feet

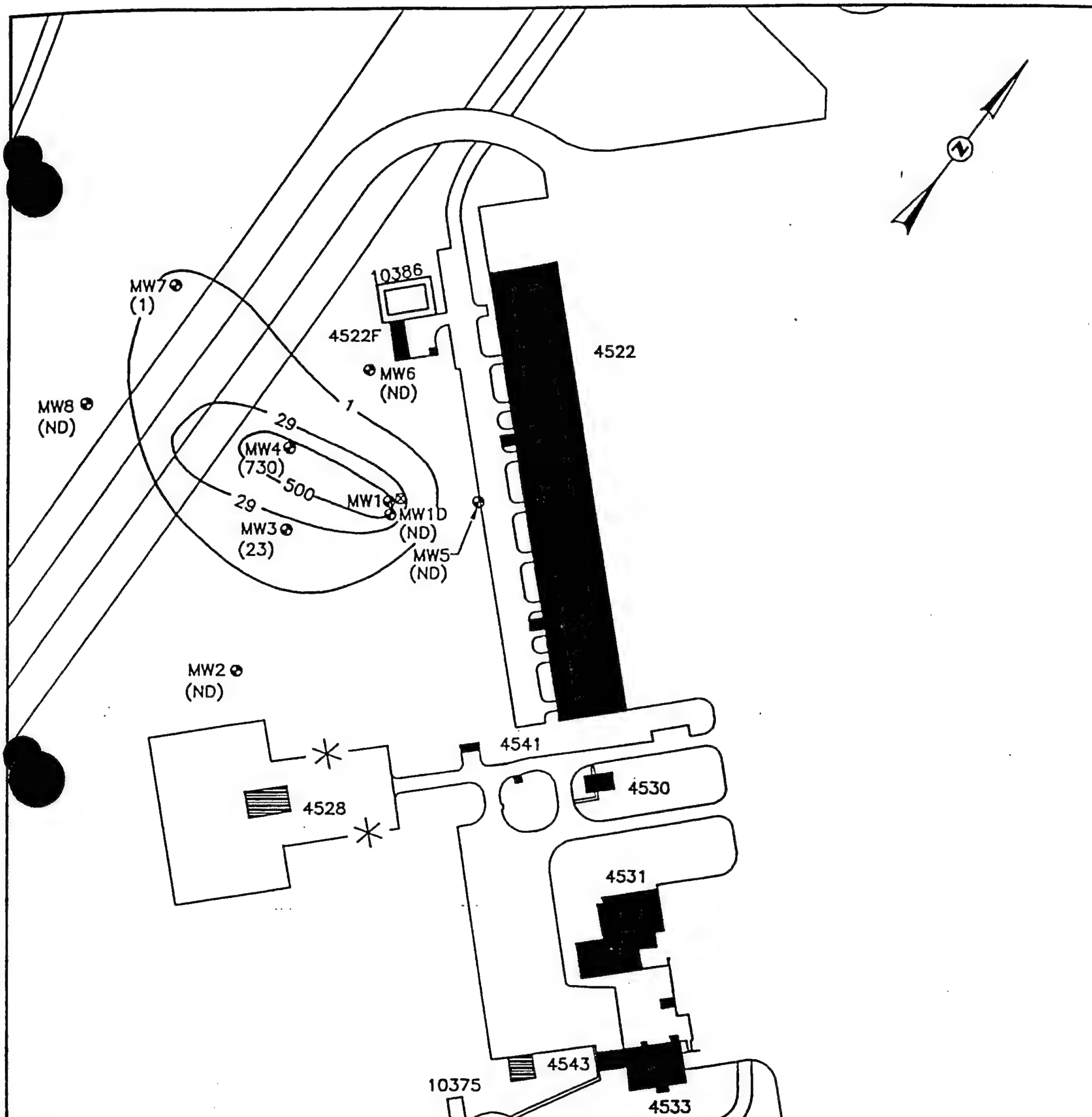
Figure 4.5

Benzene Isoconcentrations

Seymour Johnson AFB, Goldsboro,

PARSONS ENGINEERING SCIENCE, INC.

Cary, North Carolina



NOTE: MW–1D NOT USED TO CONSTRUCT MAP.

LEGEND

⊛	MONITORING WELL (MW)
⊠	VALVE PIT
(ND)	NONE DETECTED
(23)	COMPOUND CONCENTRATIONS (μg/L)

200' 100' 0 200'

Approximate Scale in Feet

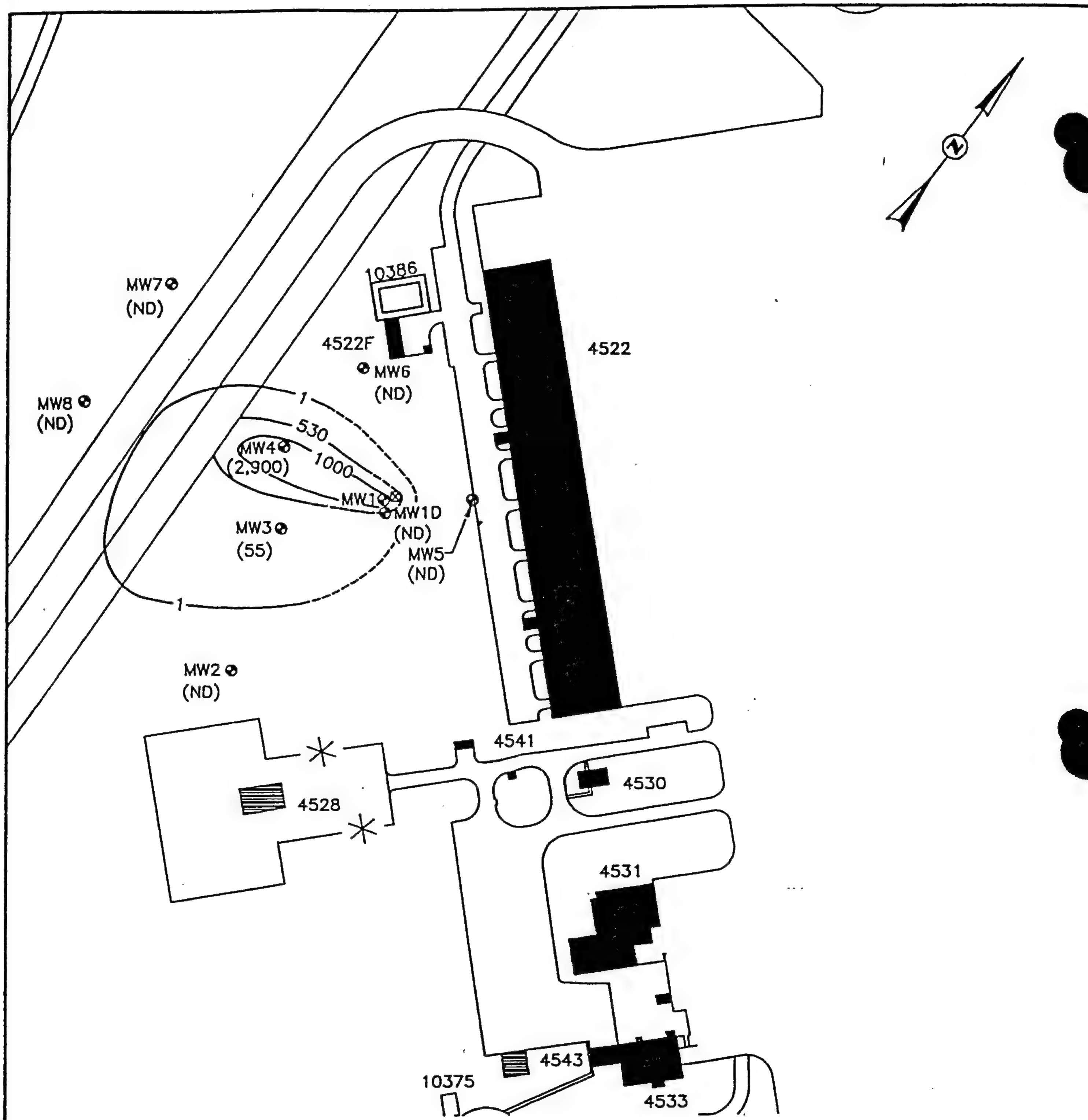
Figure 4.6

Ethylbenzene Isoconcentrations

Seymour Johnson AFB, Goldsboro, NC

PARSONS ENGINEERING SCIENCE, INC.

Cary, North Carolina



NOTE: MW–1D NOT USED TO CONSTRUCT MAP.

LEGEND

- MONITORING WELL (MW)
- VALVE PIT
- (ND) NONE DETECTED
- (55) COMPOUND CONCENTRATIONS (ug/L)

200' 100' 0 200'

Approximate Scale in Feet

Figure 4.7

Xylenes Isoconcentrations

Seymour Johnson AFB, Goldsboro, NC

PARSONS ENGINEERING SCIENCE, INC.

Cary, North Carolina

SJ039.DWG / 1=1 / 7-23-96 /

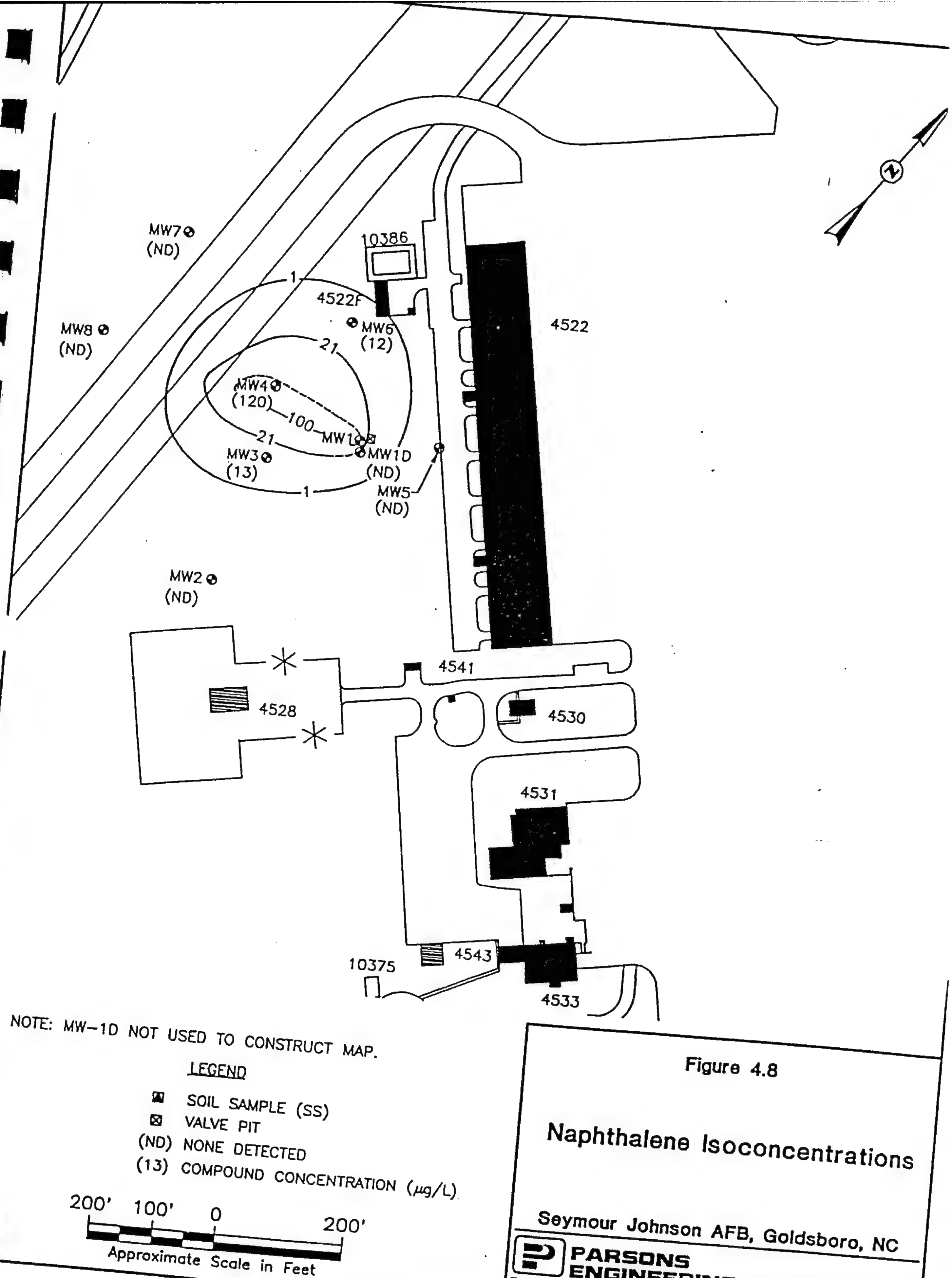


Figure 4.8

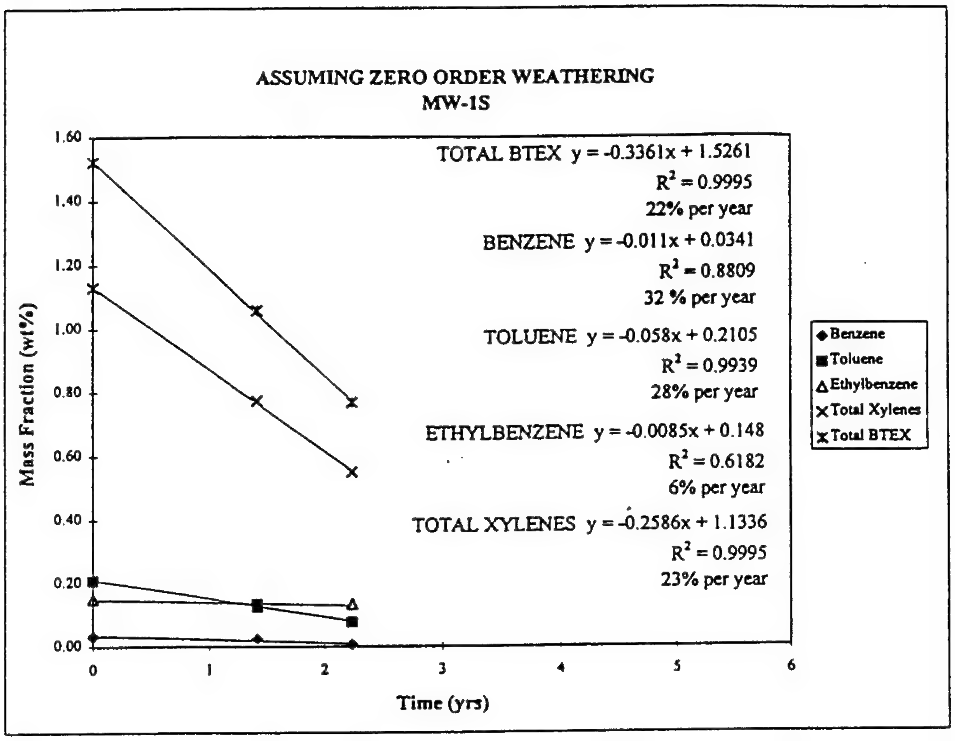
Naphthalene Isoconcentrations

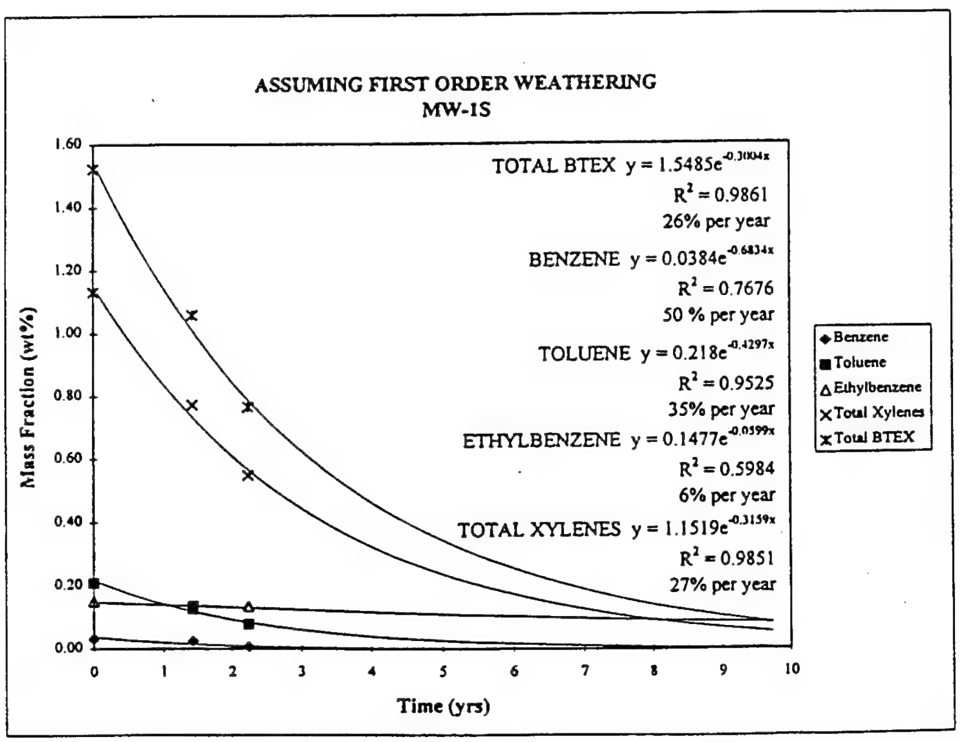
Seymour Johnson AFB, Goldsboro, NC

PARSONS ENGINEERING SCIENCE, INC.
Cary, North Carolina

FUEL WEATHERING STUDY

FIGURE __
BTEX WEATHERING IN JP-8 MOBILE LNAPL (EAL) Evergreen Analytical Laboratory
RELEASED IN DECEMBER 1995
BLDG 4522, SEYMOUR JOHNSON AFB, NORTH CAROLINA

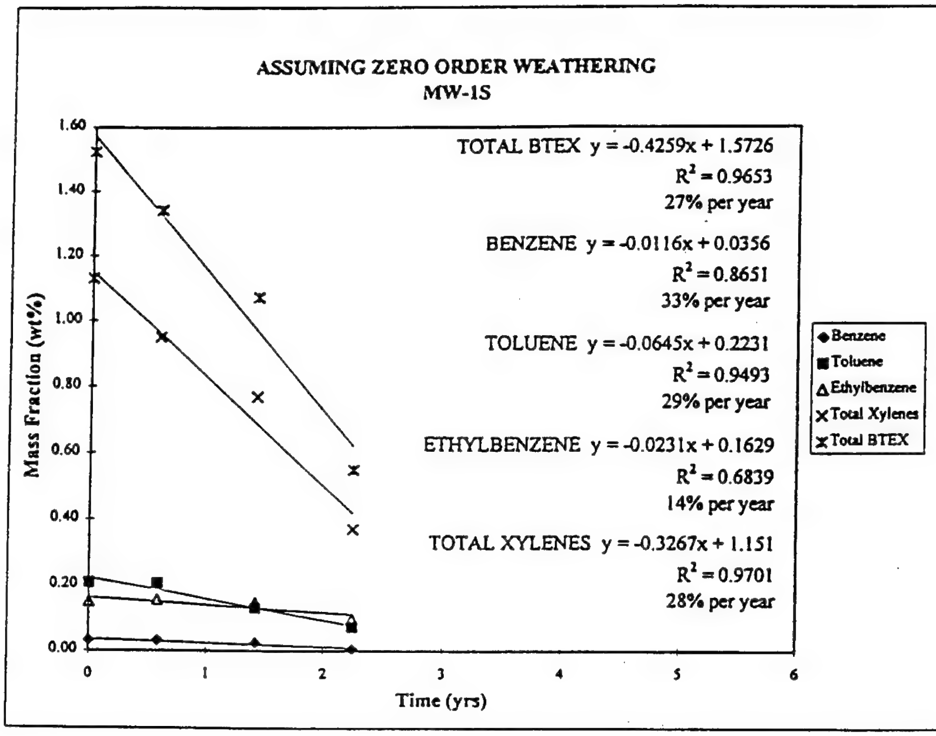


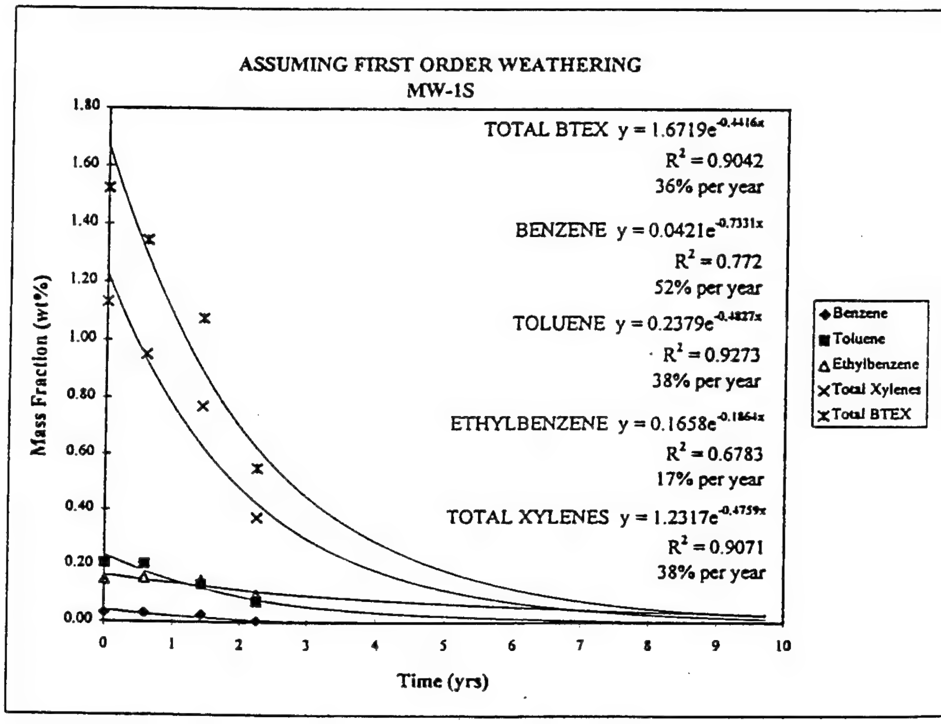


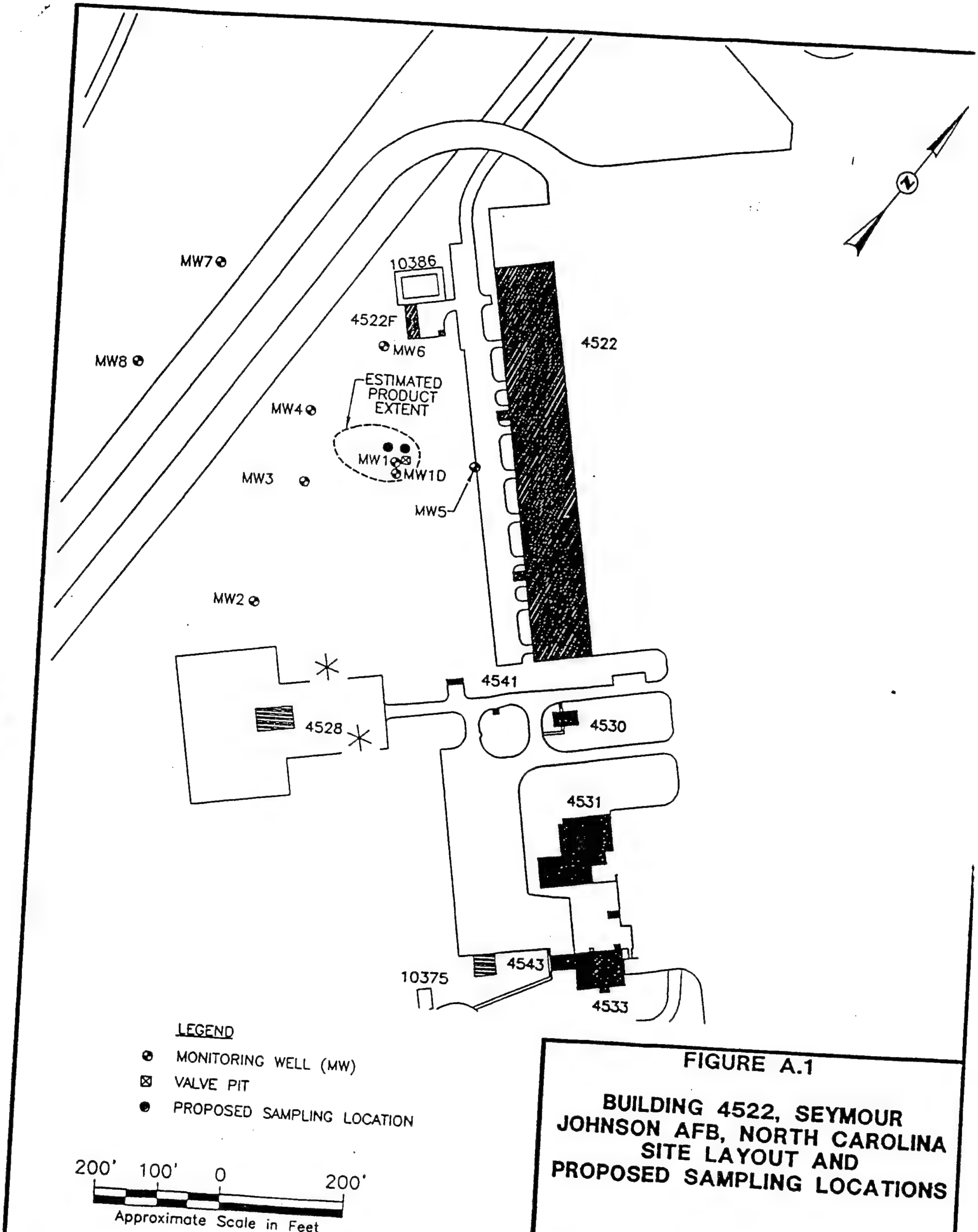
s:\es\remed\bioplume\weather\dataeval\JP-8_FP.XLS\sjplotEAL

8/11/98 3:01 PM

FIGURE __
BTEX WEATHERING IN JP-8 MOBILE LNAPL (NRMRL) National Risk Management Research Laboratory
RELEASED IN DECEMBER 1995
BLDG 4522, SEYMOUR JOHNSON AFB, NORTH CAROLINA







SOURCE: PARSONS ES, 1996

FIGURE A.1

BUILDING 4522, SEYMOUR JOHNSON AFB, NORTH CAROLINA SITE LAYOUT AND PROPOSED SAMPLING LOCATIONS

Fuel Weathering Study

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

K:\TEMP\SJ039.DWG

APPENDIX C

FIELD DATA FORMS

MONITORING WELL DEVELOPMENT RECORD

Job Number: 731854.05000
Location: MPA
Well Identification: 985J MPA

Job Name:
by T. DRAGOO
Date: 12/4/98
Measurement Datum: ____

Pre-Development Information

Time (Start): 0840

Water Level: ____
Total Depth of Well: ____

Water Characteristics

Color ____ Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material ____
pH ____ Temperature (°C) ____
Specific Conductance (µS/cm) ____
Dissolved Oxygen (mg/L) ____
Redox (mV) ____

Interim Water Characteristics

Gallons Removed ____

pH ____

Temperature (°C) ____

Specific Conductance(µS/cm) ____

Dissolved Oxygen (mg/L) ____

Redox (mV) ____

TD = 11'6" bgs
Screen = 5'
Nat Sand pack = 9'9" bgs
Sand 20-30 medium = 2' bgs
Bentonite = 0.6' bgs
Sand = cover

Post-Development Information

Time (Finish): 0915

Water Level: 9.6' bgs
Total Depth of Well: 11.5' bgs

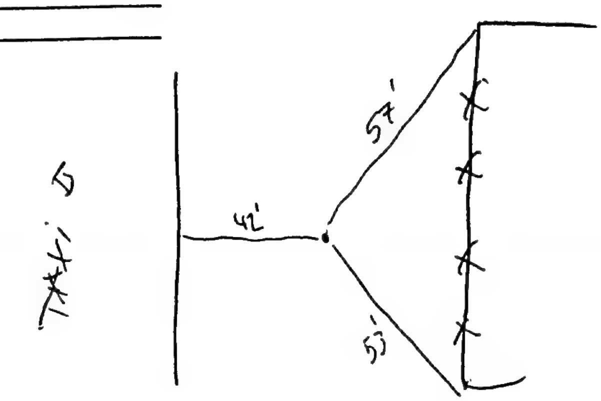
Approximate Volume Removed: ____

Water Characteristics

Color ____ Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material ____
pH ____ Temperature (°C) ____
Specific Conductance (µS/cm) ____
Dissolved Oxygen (mg/L) ____
Redox (mV) ____

Location

Comments:



MONITORING WELL DEVELOPMENT RECORD

Job Number: 731854.05000
Location: MPB (19.5 feet ~~east~~ west of MW1)
Well Identification: 985JMPB-11.5

Job Name:
by: T. Drayes
Date: 12-2-98
Measurement Datum:

Pre-Development Information

Time (Start): 0930

Water Level:

Total Depth of Well: 11.5'

Water Characteristics

Color ______ Clear Cloudy
Odor: None Weak Moderate Strong Fuel odor
Any Films or Immiscible Material
pH ______ Temperature (°C)
Specific Conductance (µS/cm)
Dissolved Oxygen (mg/L)
Redox (mV)

Interim Water Characteristics

Gallons Removed

pH

Temperature (°C)

Specific Conductance(µS/cm)

Dissolved Oxygen (mg/L)

Redox (mV)

Post-Development Information

Time (Finish): 1000

Water Level:

Total Depth of Well: 11.5'

11.5 to 6.5 screen

Approximate Volume Removed:

Water Characteristics

Color ______ Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material
pH ______ Temperature (°C)
Specific Conductance (µS/cm)
Dissolved Oxygen (mg/L)
Redox (mV)

Comments:
11.5' to 7.5' - natural sand collapse
7.5' to 2' - sand 20-30 medium (Bonsal
2' to 1.5' - bentonite
.5' to 0' - native soil

GROUNDWATER SAMPLING RECORD

Sampling Location ____________
Sampling Dates 12-4-98

GROUND WATER SAMPLING RECORD - MONITORING WELL MP-A
(number)

REASON FOR SAMPLING: [ ] Regular Sampling; [X] Special Sampling;
DATE AND TIME OF SAMPLING: ________, 1998 ________ a.m./p.m.
SAMPLE COLLECTED BY: M. Jackson of Parsons ES
WEATHER: Sunny, 60°–70° F
DATUM FOR WATER DEPTH MEASUREMENT (Describe): ____________

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: Good
INNER PVC CASING CONDITION IS: Good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe): ____________

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH ____________
Items Cleaned (List): ____________

2 [ ] PRODUCT DEPTH ____________ FT. BELOW DATUM
Measured with: ____________

WATER DEPTH DTW= 9.50 DTB= 11.5 FT. BELOW DATUM
Measured with: ____________

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: ____________
Odor: ____________
Other Comments: ____________

4 [ ] WELL EVACUATION:
Method: ____________
Volume Removed: ____________
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: ____________
Other comments: ____________

Groundwater Sampling Record

Monitoring Well No. MP- A (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[X] Pump, type: Peristaltic
[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

DIRECT INSTRUMENT READINGS

Time	12:27 →	12:33	12:37				Measured With
Temp (°C)	24.0	25.3	24.7				
pH	N/A (2.3)	N/A (2.3)	N/A (2.8)				
Cond (µS/cm)	193	194	130 **				
Do (mg/L)	1.13	1.12	2.00				
Redox (mv)	30.6	12.9	14.7 "				
gallons purged	1/8 gal	0.25	0.50				

FIELD CHEMISTRY RESULTS

Analyte	Dilution?	Concentration	Observations/Notes
(1) Sulfate			
(2) Sulfide			
(3) Nitrate			
(4) Nitrite			
(5) Manganese			
(6) Ferrous Iron	Y (5 to 1)	(5) x (1.12) → 5.60	20ml sample + 80ml H_2O D.I.
(7) Total Iron			
(8) Alkalinity	N	VIOLET → 15 Pink → 20	VIOLET = 3 drops H_2SO_4
(9) Carbon Dioxide			
(10) Chloride	~~N~~	~~0.3~~	
Ammonia	N	0.3	

Additional Comments: Went Dry @ 1/8 gallon. slowed pump down to try develop & purge
** orp submerged

7 [ ] SAMPLE CONTAINERS (material, number, size):

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method ______ Containers: ______
Method ______ Containers: ______

[ ] Preservatives added:
Method ______ Containers: ______

9 [ ] CONTAINER HANDLING:

[ ] Container Sides Labeled
[ ] Container Lids Taped
[ ] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:

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GROUNDWATER SAMPLING RECORD

Sampling Location MW-7 Seymour
Sampling Dates 12/1/98

GROUND WATER SAMPLING RECORD - MONITORING WELL MW-7
(number)

REASON FOR SAMPLING: [ ] Regular Sampling; [X] Special Sampling;
DATE AND TIME OF SAMPLING: ________, 1998 ________ a.m./p.m.
SAMPLE COLLECTED BY: MDJ of Parsons ES
WEATHER: Sunny 60°- 70° F
DATUM FOR WATER DEPTH MEASUREMENT (Describe): DTW = 8.10 DTW = 10.10

MONITORING WELL CONDITION:

[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: Good
INNER PVC CASING CONDITION IS: OK (2.5" PVC)
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH
Items Cleaned (List):

2 [ ] PRODUCT DEPTH ________ FT. BELOW DATUM
Measured with:

WATER DEPTH ________ FT. BELOW DATUM
Measured with:

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance:
Odor:
Other Comments:

4 [ ] WELL EVACUATION:
Method:
Volume Removed:
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors:
Other comments:

Groundwater Sampling Record

Monitoring Well No. MW - 7 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:

[X] Pump, type: Peristaltic

[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

Ref solns [ ] ON-SITE MEASUREMENTS:

pH 7 pillow buffers

other meter

tubing

9 filters Hach 2530 Filter, Glass Fiber 47mm pk/100 (#7 for pope)

DIRECT INSTRUMENT READINGS

							Measured With
Time	9:44	9.46	9.48				
Temp (°C)	19.7	19.7	19.7				
* pH	N/A (3.61)	N/A (3.83)	6.55 N/A				
Cond (µS/cm)	122	122	121				
Do (mg/L)	3.79	3.58	3.46				
Redox (mv)	26.8	36.9	39.5				
gallons purged	0.25	0.50	0.75	WENT DRY @ 0.80 Gallons			

FIELD CHEMISTRY RESULTS

Analyte	Dilution?	Concentration	Observations/Notes
(1) Sulfate			
(2) Sulfide			
(3) Nitrate			
(4) Nitrite			
(5) Manganese			
(6) Ferrous Iron	Yes ⇒ 5 to 1	(1.33) x (5) ⇒ 6.65	10 ml total = 2 ml + 8 ml H_2O
(7) Total Iron			
(8) Alkalinity	No	Violet → 20 Pink → 25	(Violet color at 4 drops
(9) Carbon Dioxide			
(10) Chloride			
Ammonium	No	0.3	

Additional Comments: * 12/4/98 ⇒ Horiba pH meter will not calibrate to 4, 7, or 10.

7 [ ] SAMPLE CONTAINERS (material, number, size):

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method ___ Containers: ___
Method ___ Containers: ___

[ ] Preservatives added:
Method ___ Containers: ___

9 [ ] CONTAINER HANDLING:

[ ] Container Sides Labeled

[ ] Container Lids Taped

[ ] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:

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GROUNDWATER SAMPLING RECORD

Sampling Location MW-8 (Seymour)
Sampling Dates 12-1-98

GROUND WATER SAMPLING RECORD - MONITORING WELL ________________
(number)

REASON FOR SAMPLING: [ ] Regular Sampling; [X] Special Sampling;
DATE AND TIME OF SAMPLING: ________, 1998 ________ a.m./p.m.
SAMPLE COLLECTED BY: M. Jackson of Parsons ES
WEATHER: Sunny 60° - 70° F
DATUM FOR WATER DEPTH MEASUREMENT (Describe): DTW = 7.44

MONITORING WELL CONDITION:

[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: Good
INNER PVC CASING CONDITION IS: Good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe): ________________

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH ________________
Items Cleaned (List): ________________

2 [ ] PRODUCT DEPTH ________________ FT. BELOW DATUM
Measured with: ________________

WATER DEPTH ________________ FT. BELOW DATUM
Measured with: ________________

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: ________________
Odor: ________________
Other Comments: ________________

4 [ ] WELL EVACUATION:
Method: ________________
Volume Removed: ________________
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: ________________
Other comments: ________________

Groundwater Sampling Record

Monitoring Well No. MW-8 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[X] Pump, type: Peristaltic
[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

DIRECT INSTRUMENT READINGS

Time	11:08	11:01					Measured With
Temp (°C)	19.8	WENT	DRY @	0.40 GALLONS			
pH	N/A (3.7?)						
Cond (μS/cm)	.130						
Do (mg/L)	3.03						
Redox (mv)	122.7						
gallons purged	0.25						

FIELD CHEMISTRY RESULTS

Analyte	Dilution?	Concentration	Observations/Notes
(1) Sulfate			
(2) Sulfide			
(3) Nitrate			
(4) Nitrite			
(5) Manganese			
(6) Ferrous Iron			
(7) Total Iron			
(8) Alkalinity			
(9) Carbon Dioxide			
(10) Chloride			

Additional Comments:

7 [ ] SAMPLE CONTAINERS (material, number, size):

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method ___ Containers: ___
Method ___ Containers: ___

[ ] Preservatives added:
Method ___ Containers: ___

9 [ ] CONTAINER HANDLING:

[ ] Container Sides Labeled
[ ] Container Lids Taped
[ ] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:

GROUNDWATER SAMPLING RECORD

Sampling Location MW-5
Sampling Dates 12-2-98

GROUND WATER SAMPLING RECORD - MONITORING WELL MW-5
(number)

REASON FOR SAMPLING: [ ] Regular Sampling; [X] Special Sampling;
DATE AND TIME OF SAMPLING: ________, 1998 ________ a.m./p.m.
SAMPLE COLLECTED BY: M. Jackson of Parsons ES
WEATHER: Sunny, 60° - 70° F
DATUM FOR WATER DEPTH MEASUREMENT (Describe): DTW = 9.25
SIZE → 2"

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: Good
INNER PVC CASING CONDITION IS: Good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe): ________

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH ________
Items Cleaned (List): ________

2 [ ] PRODUCT DEPTH ________ FT. BELOW DATUM
Measured with: ________

WATER DEPTH ________ FT. BELOW DATUM
Measured with: ________

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: ________
Odor: ________
Other Comments: ________

4 [ ] WELL EVACUATION:
Method: ________
Volume Removed: ________
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: NO ODOR
Other comments: ________

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Groundwater Sampling Record

Monitoring Well No. MW-3 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[X] Pump, type: Peristaltic
[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

DIRECT INSTRUMENT READINGS

Time	14:20	14:23	14:27				Measured With
Temp (°C)	23.1	23.0	23.1				
pH	5.54	5.22	4.88				#2 → 5.23
Cond (µS/cm)	77	99	113				
Do (mg/L)	0.94	0.90	0.89				
Redox (mv)	166.6	178.9	207.1				
gallons purged	0.25	0.56	1.0	WENT DRY	@ 1.25		GALLON

FIELD CHEMISTRY RESULTS

Analyte	Dilution?	Concentration	Observations/Notes
(1) Sulfate	NO	24.6	
(2) Sulfide			
(3) Nitrate			
(4) Nitrite			
(5) Manganese			
(6) Ferrous Iron	NO	0.22	LIGHT PINK
(7) Total Iron			
(8) Alkalinity	NO	35.0	LIGHT PINK (40 DARK)
(9) Carbon Dioxide			
(10) Chloride			
AMMONIA	NO	0.0	

Additional Comments:

7 [ ] SAMPLE CONTAINERS (material, number, size):

8 [ ] ON-SITE SAMPLE TREATMENT:

[X] Filtration: Method ____ Containers: ____
Method ____ Containers: ____

[ ] Preservatives added:
Method ____ Containers: ____

9 [ ] CONTAINER HANDLING:

[ ] Container Sides Labeled
[ ] Container Lids Taped
[ ] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:

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GROUNDWATER SAMPLING RECORD

Sampling Location __________
Sampling Dates 12-2-98

GROUND WATER SAMPLING RECORD - MONITORING WELL MW-2
(number)

REASON FOR SAMPLING: [ ] Regular Sampling; [X] Special Sampling;
DATE AND TIME OF SAMPLING: ________, 1998 ________ a.m./p.m.
SAMPLE COLLECTED BY: M. Jackson of Parsons ES
WEATHER: Sunny 60° - 70° F
DATUM FOR WATER DEPTH MEASUREMENT (Describe): DTW = 4.20 DTB = 13.15
3126 → 2"

MONITORING WELL CONDITION:

[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: Good
INNER PVC CASING CONDITION IS: Good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe): __________

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH __________
Items Cleaned (List): __________

2 [ ] PRODUCT DEPTH __________ FT. BELOW DATUM
Measured with: __________

WATER DEPTH __________ FT. BELOW DATUM
Measured with: __________

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: __________
Odor: __________
Other Comments: __________

4 [ ] WELL EVACUATION:
Method: __________
Volume Removed: __________
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: __________
Other comments: __________

Groundwater Sampling Record

Monitoring Well No. MW-2 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[X] Pump, type: Peristaltic
[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

DIRECT INSTRUMENT READINGS

							Measured With
Time	17:34	17:38	17:44	17:52	17:57		
Temp (°C)	17.1	17.0	17.0	16.9	16.9		
pH	4.72	4.68	4.61	4.60	4.6		
Cond (µS/cm)	118	121	124	124	123		
Do (mg/L)	1.12	1.01	1.01	1.12	1.12		
Redox (mv)	217	221.7	222.4	226.6	227.7		
gallons purged	1.0	1.5	3.0	3.5	4.5		

FIELD CHEMISTRY RESULTS

Analyte	Dilution?	Concentration	Observations/Notes
(1) Sulfate		25.4	
(2) Sulfide			
(3) Nitrate			
(4) Nitrite			
(5) Manganese			
(6) Ferrous Iron	NO	0.21	
(7) Total Iron			
(8) Alkalinity	NO	5.0	
(9) Carbon Dioxide			
(10) Chloride			
Ammonium	NO	0.0	

Additional Comments:

7 [ ] SAMPLE CONTAINERS (material, number, size):

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method ___ Containers: ___
Method ___ Containers: ___

[ ] Preservatives added:
Method ___ Containers: ___

9 [ ] CONTAINER HANDLING:

[ ] Container Sides Labeled
[ ] Container Lids Taped
[ ] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:

GROUNDWATER SAMPLING RECORD

Sampling Location ______________
Sampling Dates 12-3-98

GROUND WATER SAMPLING RECORD - MONITORING WELL MW-3 (number)

REASON FOR SAMPLING: [ ] Regular Sampling; [X] Special Sampling;
DATE AND TIME OF SAMPLING: ________, 1998 ________ a.m./p.m.
SAMPLE COLLECTED BY: M. Jackson of Parsons ES
WEATHER: Sunny 60°-70° F
DATUM FOR WATER DEPTH MEASUREMENT (Describe): DTW = 5.55 DTB = 13.9

MONITORING WELL CONDITION:

[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: Good
INNER PVC CASING CONDITION IS: Good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe): ______________

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH ______________
Items Cleaned (List): ______________

2 [ ] PRODUCT DEPTH ______________ FT. BELOW DATUM
Measured with: ______________

WATER DEPTH ______________ FT. BELOW DATUM
Measured with: ______________

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: ______________
Odor: ______________
Other Comments: ______________

4 [ ] WELL EVACUATION:
Method: ______________
Volume Removed: ______________
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: ______________
Other comments: ______________

Groundwater Sampling Record

Monitoring Well No. MW-3 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of: ________
[X] Pump, type: Peristaltic
[ ] Other, describe: ________

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

DIRECT INSTRUMENT READINGS

Time	16:40	16:43	16:45	16:48	16:53	16:58	Measured With
Temp (°C)	18.7	18.6	18.5	18.4	18.2	18.1	
pH *	5.71	5.74	5.75	5.77	5.80	5.80	
Cond (µS/cm)	131	130	129	128	127	127	
Do (mg/L)	2.43	2.13	1.83	1.60	1.30	1.16	
Redox (mv)	268.4	168.0	-5.8	-142.5	-164.1	-172.2	
gallons purged	0.5	1.0	1.5	2.5	3.5	4.0	

FIELD CHEMISTRY RESULTS

Analyte	Dilution?	Concentration	Observations/Notes
(1) Sulfate			
(2) Sulfide			
(3) Nitrate			
(4) Nitrite			
(5) Manganese			
(6) Ferrous Iron	N	2.56	
(7) Total Iron			
(8) Alkalinity	N	Violet → 10 Pink → 15	
(9) Carbon Dioxide			
(10) Chloride			
Ammonium	N	0.2	

Additional Comments: * pH meter not calib. to pH 7 (or 10), will calib. to 4. Error 9 displayed. Not operating the same since use at MP-B.

7 [ ] SAMPLE CONTAINERS (material, number, size): ________

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method ________ Containers: ________
Method ________ Containers: ________

[ ] Preservatives added:
Method ________ Containers: ________

9 [ ] CONTAINER HANDLING:

[ ] Container Sides Labeled
[ ] Container Lids Taped
[ ] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: ________

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GROUNDWATER SAMPLING RECORD

Sampling Location ______________
Sampling Dates 12-2-98

GROUND WATER SAMPLING RECORD - MONITORING WELL MW-4
(number)

REASON FOR SAMPLING: [ ] Regular Sampling; [X] Special Sampling;
DATE AND TIME OF SAMPLING: ________, 1998 ________ a.m./p.m.
SAMPLE COLLECTED BY: M. Jackson of Parsons ES
WEATHER: Clear 70°F
DATUM FOR WATER DEPTH MEASUREMENT (Describe): DTW = 7.08 (12/1/98)
Riser

MONITORING WELL CONDITION:

[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: Good
INNER PVC CASING CONDITION IS: Good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe): ______________

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH ______________
Items Cleaned (List): ______________

2 [ ] PRODUCT DEPTH ______________ FT. BELOW DATUM
Measured with: ______________

WATER DEPTH ______________ FT. BELOW DATUM
Measured with: ______________

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: Clear, LNAPL Blobs on Purge H2O surface
Odor: H Odor
Other Comments: ______________

4 [ ] WELL EVACUATION:
Method: Peris. Pump. 12/2/98 10:00am
Volume Removed: ______________
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: ______________
Other comments: ______________

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Groundwater Sampling Record

Monitoring Well No. MW-4 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

- [ ] Bailer made of: ______
- [ ] Pump, type: X Peristaltic
- [ ] Other, describe: ______

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

DIRECT INSTRUMENT READINGS

Time	10:02	10:12	10:17	10:23	10:26		Measured With
Temp (°C)	19.4	19.7	19.7	19.8	19.8		
pH	6.07	6.16	6.21	6.26	6.25		
Cond (µS/cm)	45	38	48	36	44		
Do (mg/L)	0.93	0.68	0.52	0.48	0.45		
Redox (mv)	37.0	-44.1	-59.5	-64.2	-68.9		
gallons purged	0.25	1.25	2.50	3.00	3.5		

FIELD CHEMISTRY RESULTS

Analyte	Dilution?	Concentration	Observations/Notes
(1) Sulfate	NO	~~0.0 (16.7 abs.)~~	36.1
(2) Sulfide			
(3) Nitrate			
(4) Nitrite			
(5) Manganese			
(6) Ferrous Iron	NO	> 5.10 (4.64)(5)	(Dilute 0.20ml & 0.80ml Dist.)
(7) Total Iron			
(8) Alkalinity		70 mg/l	HACH KIT
(9) Carbon Dioxide			
(10) Chloride			
Ammonium		>10².	Org ~~[illegible]~~ color due to Iron
			Probably very low amount

10m
23.2

Additional Comments: ______

7 [ ] SAMPLE CONTAINERS (material, number, size): ______

8 [ ] ON-SITE SAMPLE TREATMENT:

[X] Filtration: Method 47mm Fiber Containers: ______
Method ______ Containers: ______

[ ] Preservatives added:
Method ______ Containers: ______

9 [ ] CONTAINER HANDLING:

- [ ] Container Sides Labeled
- [ ] Container Lids Taped
- [ ] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: ______

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GROUNDWATER SAMPLING RECORD

Sampling Location ____________
Sampling Dates ____________

GROUND WATER SAMPLING RECORD - MONITORING WELL MW-6
(number)

REASON FOR SAMPLING: [ ] Regular Sampling; [X] Special Sampling;
DATE AND TIME OF SAMPLING: 12/2/98 1998 8:00 a.m./p.m.
SAMPLE COLLECTED BY: M. Jackson of Parsons ES
WEATHER: Sunny Cool - 70° F
DATUM FOR WATER DEPTH MEASUREMENT (Describe): DTW = 8.64 TBP = 3.5 Gallons
SIZE → 1.5"

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: Good
INNER PVC CASING CONDITION IS: Good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe): ____________

Check-off
1 [ ] EQUIPMENT CLEANED BEFORE USE WITH ____________
Items Cleaned (List): ____________

2 [ ] PRODUCT DEPTH ____________ FT. BELOW DATUM
Measured with: ____________

WATER DEPTH ____________ FT. BELOW DATUM
Measured with: ____________

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: ____________
Odor: ____________
Other Comments: ____________

4 [ ] WELL EVACUATION:
Method: ____________
Volume Removed: ____________
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: ____________
Other comments: ____________

Groundwater Sampling Record

Monitoring Well No. MW-6 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:

[X] Pump, type: PERISTALTIC

[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

DIRECT INSTRUMENT READINGS

							Measured With
Time	17:38						
Temp (°C)	18.2						HORIBA
pH	5.04						HORIBA
Cond (μS/cm)	114						↓
Do (mg/L)	3.15						YSI
Redox (mv)	137.2						ORP
gallons purged	0.25						

FIELD CHEMISTRY RESULTS

Analyte	Dilution?	Concentration	Observations/Notes
(1) Sulfate	—	~~3.4~~ 19.0	
(2) Sulfide			
(3) Nitrate			
(4) Nitrite			
(5) Manganese			
(6) Ferrous Iron	—	1.07	
(7) Total Iron			
(8) Alkalinity		~~(>500+)~~ 4(5×10)	
(9) Carbon Dioxide			
(10) Chloride			
Amm		0.0	

Additional Comments:

7 [ ] SAMPLE CONTAINERS (material, number, size): VOAS (40m pres, 3)

8 [ ] ON-SITE SAMPLE TREATMENT:

[X] Filtration: Method Containers:
Method Containers:

[ ] Preservatives added:
Method Containers:

9 [ ] CONTAINER HANDLING:

[ ] Container Sides Labeled

[ ] Container Lids Taped

[ ] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:

GROUNDWATER SAMPLING RECORD

Sampling Location ______________
Sampling Dates ______________

GROUND WATER SAMPLING RECORD - MONITORING WELL MW-B
(number)

REASON FOR SAMPLING: [ ] Regular Sampling; [X] Special Sampling;
DATE AND TIME OF SAMPLING: 12-2, 1998 ________ a.m./p.m.
SAMPLE COLLECTED BY: M. Jackson of Parsons ES
WEATHER: Sunny, 60° - 70° F
DATUM FOR WATER DEPTH MEASUREMENT (Describe): DTLNAPL DTW = 8.5 . DTB = 11.5

MONITORING WELL CONDITION:

[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: Good
INNER PVC CASING CONDITION IS: Good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe): ______________

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH ______________
Items Cleaned (List): ______________

2 [ ] PRODUCT DEPTH ______________ FT. BELOW DATUM
Measured with: ______________

WATER DEPTH ______________ FT. BELOW DATUM
Measured with: ______________

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: ______________
Odor: ______________
Other Comments: ______________

4 [ ] WELL EVACUATION:
Method: ______________
Volume Removed: ______________
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: HC odor strong, LNAPL Beads (?)
Other comments: ______________

Groundwater Sampling Record

Monitoring Well No. MB-B (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:

[X] Pump, type: Peristaltic

[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

DIRECT INSTRUMENT READINGS

							Measured With
Time	16:10	16:14	16:18	16:21	16:25		
Temp (°C)	19.4	19.3	19.3	19.3	19.3		
pH	5.19	5.07	5.00	4.97	4.97		
Cond (µS/cm)	95	97	100	106	107		
Do (mg/L)	1.31	0.84	0.72	0.59	0.58		
Redox (mv)	-71.1	-112.4	-149.1	-169.1	-163.2		
gallons purged	0.25	0.5	1.0	1.25	1.50		

FIELD CHEMISTRY RESULTS

Analyte	Dilution?	Concentration	Observations/Notes
(1) Sulfate	N	10.3	
(2) Sulfide			
(3) Nitrate			
(4) Nitrite			
(5) Manganese			
(6) Ferrous Iron	4 (20ml sample, 80	(2.4) x (5) = 10.2	20ml diluted with 80ml DIW.
(7) Total Iron			
(8) Alkalinity	—	35 mg/l	(7 drops purple, 8 pink →
(9) Carbon Dioxide			
(10) Chloride			
Ammonia		0.0	

Additional Comments:

7 [ ] SAMPLE CONTAINERS (material, number, size):

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method ______ Containers: ______
Method ______ Containers: ______

[ ] Preservatives added:
Method ______ Containers: ______

9 [ ] CONTAINER HANDLING:

[ ] Container Sides Labeled

[ ] Container Lids Taped

[ ] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: Line initially purged prior to clean purge H_2O. (0.5 Gallons of TBD H_2O purged prior to clean purge H_2O). Purge 2.5 Gallons Total. Does not go dry.

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GEOLOGIC BORING LOG

BORING NO.: 98SJSB5
CONTRACTOR: Parsons ES
DATE SPUD:
CLIENT: AFCEE
RIG TYPE: Geoprobe
DATE CMPL.: 12/2/98 1630
JOB NO.: 731854.05000
DRLG METHOD: Geoprobe (Direct Push)
ELEVATION: 100+ MSL
LOCATION: (13' N of MW2)
BORING DIA.: 2"
TEMP: 60°-70° F
GEOLOGIST: T. DRAGOO
DRLG FLUID:
WEATHER: Sunny
COMMENTS:

Elev (ft)	Depth (ft)	Pro-file	USCS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID(ppm)	TLV(ppm)	TOTAL BTEX(ppm)	TPH (ppm)
				Fill								
	1			Silty ~~Sand~~ Clay w/ organics brown & gray, no odor		2.5-3	T		10			
3.5'				Silty Sands brown & tan, no odor								
	5											
	10											
	15											
	20											
	25											
	30											
	35											

NOTES

- bgs – Below Ground Surface
- GS – Ground Surface
- TOC – Top of Casing
- NS – Not Sampled
- SAA – Same As Above
- U – Undetected

SAMPLE TYPE

- D – DRIVE
- C – CORE
- G – GRAB

Water level drilled

T = TOC 9060n

GEOLOGIC BORING LOG

Risk-Based Approach to Remediation

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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GEOLOGIC BORING LOG

BORING NO.: 985SSB2
CLIENT: AFCEE
JOB NO.: 731854.05000
LOCATION: SB2 (9' N of MPB)(22' N of mil)
GEOLOGIST: J. DRAGOO
COMMENTS:

CONTRACTOR: Parsons ES
RIG TYPE: Geoprobe
DRLG METHOD: Geoprobe (Direct Push)
BORING DIA.: 2"
DRLG FLUID:

DATE SPUD:
DATE CMPL.: 12-2-98 1200
ELEVATION: 100 + MSL
TEMP: 60°-70° F
WEATHER: Sunny

Elev (ft)	Depth (ft)	Profile	USCS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID(ppm)	TLV(ppm)	TOTAL BTEX(ppm)	TPH (ppm)
	0–1			Fill								
	1–4.5			Silty Sand L. Brown ~~to D. Brown~~ Moderate odor		2.5-3.5	8					
						4-4.5	S	2.5-3	30-40			
								3.5-4	160			
	5			~~Silty Sand~~ ~~L. Brown to Dark brown~~ ~~Moderate Fuel odor~~ TSK		5-5.5	E,4	4.5-5	150			
								5.5-6	170			
5.5'				Silty Sand L. Brown Strong Odor								
	10			Wet silty sands D. Brown Strong odor								
	15											
	20											
	25											
	30											
	35											

NOTES
- bgs – Below Ground Surface
- GS – Ground Surface
- TOC – Top of Casing
- NS – Not Sampled
- SAA – Same As Above
- U – Undetected

SAMPLE TYPE
- D – DRIVE
- C – CORE
- G – GRAB
- Water level drilled
- 8 = 8oz SVOC
- E = Encore VPH
- 4 = 4oz EPH
- S = sleeve VOC

GEOLOGIC BORING LOG

Risk-Based Approach to Remediatio

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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GEOLOGIC BORING LOG

BORING NO.: 98SJSB3
CLIENT: AFCEE
JOB NO.: 731854.05000
LOCATION: SB3 (70' NW-MH4)
GEOLOGIST: T. DRAGOO
COMMENTS: Sampled 1030 Finish 10:45

CONTRACTOR: Parsons ES
RIG TYPE: Geoprobe
DRLG METHOD: Geoprobe (Direct Push)
BORING DIA.:
DRLG FLUID:

DATE SPUD: 12-3-98
DATE CMPL.: 12-3-98
ELEVATION: 100 + MSL
TEMP: 60°-70° F
WEATHER: Sunny

Elev (ft)	Depth (ft)	Pro-file	US CS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID (ppm)	TLV (ppm)	TOTAL BTEX (ppm)	TPH (ppm)
				Fill								
	1			SANDY Clay		2			9			
				Silty Sand L. brown Light odor		4			20			
	5			Sand Grey to Tan moderate odor		6			>200			
20 → ▽												
	10											
	15											
	20											
	25											
	30											
	35											

NOTES

bgs — Below Ground Surface
GS — Ground Surface
TOC — Top of Casing
NS — Not Sampled
SAA — Same As Above
U — Undetected

SAMPLE TYPE

D — DRIVE
C — CORE
G — GRAB

▼ Water level drilled

GEOLOGIC BORING LOG

Risk-Based Approach to Remediation

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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GEOLOGIC BORING LOG

BORING NO.: 985JSB1
CLIENT: AFCEE
JOB NO.: 731854
LOCATION: SB1 (16' South of MW1)
GEOLOGIST: T. DRAGOO
COMMENTS: Start 0900 Finish 0930 (sampled) Background PID – 1.5 ppm

CONTRACTOR: Parsons ES
RIG TYPE: Geoprobe
DRLG METHOD: Direct Push
BORING DIA.: 2"
DRLG FLUID:

DATE SPUD: 12-3-98
DATE CMPL.: 12-3-98
ELEVATION: 100 + MSL
TEMP: 60° – 70° F
WEATHER: Sunny

Elev (ft)	Depth (ft)	Pro-file	US CS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID (ppm)	TLV (ppm)	TOTAL BTEX (ppm)	TPH (ppm)
				Fill								
	1			Silty Sand & clay Moderate odor								
				Silty Sand dark brown Strong odor		2.5-3			>200			
						3-3.5			150			
						4.5-5			170			
20 →	5			Sand Gray Strong odor								
	10											
	15											
	20											
	25											
	30											
	35											

NOTES
bgs – Below Ground Surface
GS – Ground Surface
TOC – Top of Casing
NS – Not Sampled
SAA – Same As Above
U – Undetected

SAMPLE TYPE
D – DRIVE
C – CORE
G – GRAB

▼ Water level drilled

GEOLOGIC BORING LOG

Risk-Based Approach to Remediatio

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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GEOLOGIC BORING LOG

Sheet 1 of 1

BORING NO.:	98SJSB4	CONTRACTOR:	Parsons ES	DATE SPUD:	
CLIENT:	AFCEE	RIG TYPE:	Geoprobe	DATE CMPL.:	12-1-98 16:00
JOB NO.:	731854	DRLG METHOD:	Direct Push	ELEVATION:	100+ MSL
LOCATION:	SB4 (8' ~~east~~ west of MH5	BORING DIA.:	2"	TEMP:	70°
GEOLOGIST:	T. DRAGOO	DRLG FLUID:		WEATHER:	Sunny

COMMENTS:

Elev (ft)	Depth (ft)	Pro-file	US CS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID(ppm)	TLV(ppm)	TOTAL BTEX(ppm)	TPH (ppm)
	1			Fill								
				Silty Sands -L. Brown to gray -No Odor								
	5				1	5'-6'	TOC		10ppm			
▼												
	10											
	15											
	20											
	25											
	30											
	35											

NOTES

bgs – Below Ground Surface
GS – Ground Surface
TOC – Top of Casing
NS – Not Sampled
SAA – Same As Above
U – Undetected

SAMPLE TYPE

D – DRIVE
C – CORE
G – GRAB

▼ Water level drilled

GEOLOGIC BORING LOG

Risk-Based Approach to Remediation

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

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APPENDIX D

SLUG TEST DATA ANALYSIS

Client: **AFCEE**

Project: **Risk-Based Corrective Action & Site Closure Demo**

Project No.: **731854.05**

Well No.: **WM3 (Test 1)**

Test Date: **December 5, 1998**

Formation Tested:

Rising (R) or Falling (F) Head Test: **rising**

Logger Data File:

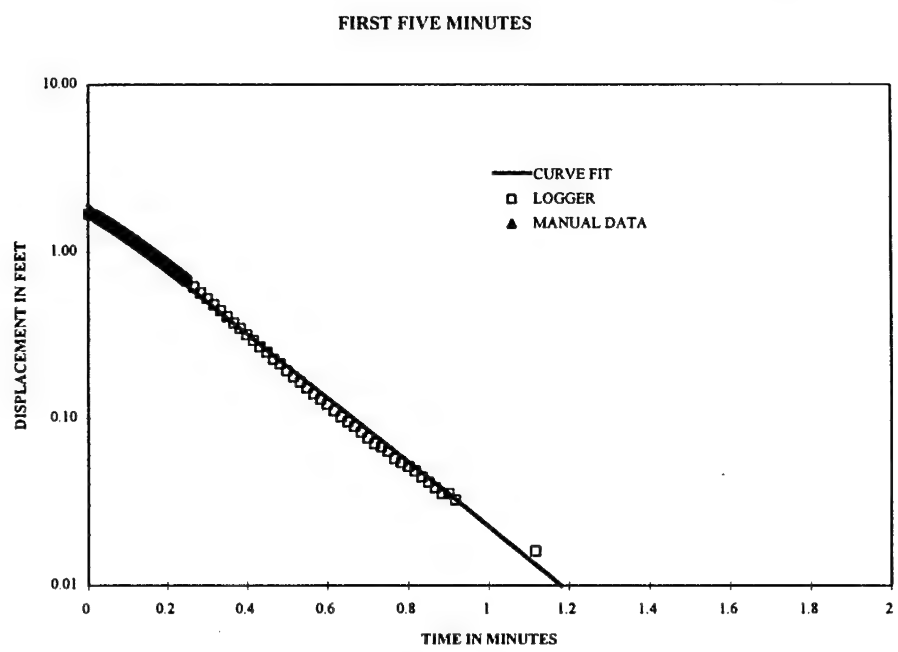
Hydraulic conductivity **2.29E-03 cm/sec**
4.51E-03 ft/min
6.49 ft/day

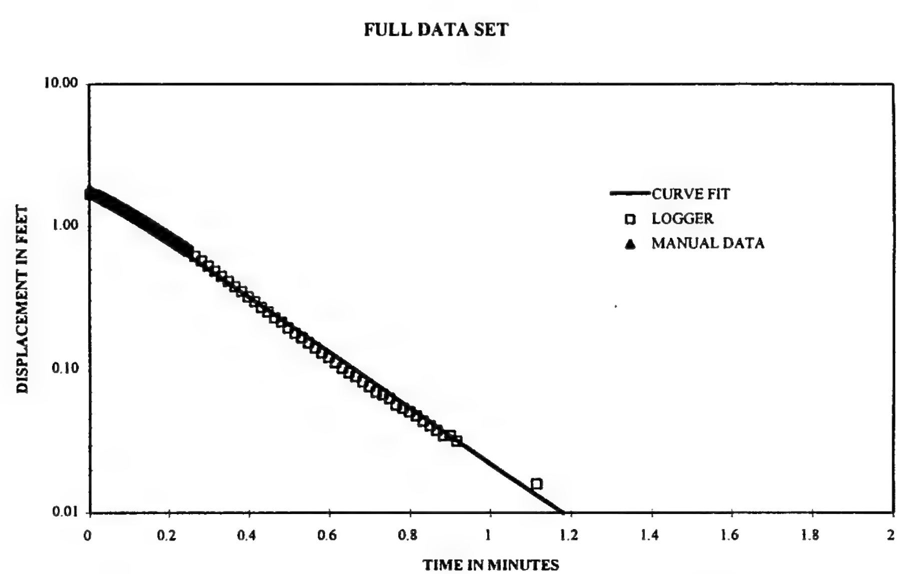
Casing stickup	0.00	feet
Static water level (from top of casing)	5.58	feet
Depth to bottom of screen (from ground level)	12.71	feet
Boring diameter	6.00	inches
Casing diameter	2.00	inches
Screen diameter	2.00	inches
Screen length	10.00	feet
Depth to "impermeable boundary"	272.24	feet
Porosity of filter pack	0.30	
Slug diameter (optional)		inches
Slug length (optional)		feet
Theoretical ΔH at time zero (Y_0)	0.00	feet
Actual ΔH at time zero (Y_0)	1.900	feet
ΔH at time t (Y_t)	0.010	feet
Time	1.18	min

Bouwer-Rice Parameters

feet	cm		cm	
5.58	170.08	*SW*		
7.13	217.32	*H*	28.52	*L/Rw*
2.71	82.60	*Ts*	0.03	*H/D*
0.250	7.62	*Rw*	2.35	*A*
0.083	2.54	*Rc*	0.33	*B*
0.167	5.08	*DS*	1.90	*C*
7.13	217.32	*L*	6.95	*Ln[(D-H)/Rw]'*
266.66	8127.80	*D*	6.00	*Ln[(D-H)/Rw]*
1.9	57.91	Y_o	2.08	equation (8)
0.01	0.30	Y_t	2.53	equation (9)
	70.80	*t (seconds)*	2.08	*Ln(Re/Rw)*
	0.30	*n*	2.3E-03	equation (5)

Bouwer, Herman. 1989. "The Bouwer and Rice Slug Test - An Update". Ground Water vol. 27, no. 3, May-June 1989.
Bouwer, H. and R.C. Rice. 1976. A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers With Completely or Partially Penetrating Wells". Water Resources Research. vol 12, no. 3, June 1976.





H_2O - 5.58 ... 2" Ø
TD - 12.71
Screen - 10'

SE1000C
Environmental Logger
01/06 16:17
MW3
Unit# 00001 Test 1

INPUT 1: Level (F) TOC

Reference	100.000
Linearity	0.050
Scale factor	10.020
Offset	-0.060
Delay mSEC	50.000

Step 0 12/05 13:51:33

	Elapsed Time	INPUT 1
	Ready	
	0.0000	100.000
	0.0033	100.000
	0.0066	100.000
	0.0100	100.000
	0.0133	100.000
	0.0166	100.000
	0.0200	100.000
	0.0233	100.000
	0.0266	100.000
	0.0300	100.000
	0.0333	100.000
	0.0366	100.000
	0.0400	100.000
	0.0433	100.000
	0.0466	100.000
	0.0500	100.003
	0.0533	100.003
	0.0566	100.000
	0.0600	100.003
	0.0633	100.469
	0.0666	100.786
	0.0700	100.783
	0.0733	101.766
	0.0766	101.747
	0.0800	101.031
	0.0833	101.205
	0.0866	101.687
	0.0900	101.680
	0.0933	101.677
	0.0966	101.671
	0.1000	101.661
	0.1033	101.642
A	0.1066	101.627
	0.1100	101.608
	0.1133	101.592
	0.1166	101.573
	0.1200	101.554
	0.1233	101.538
	0.1266	101.516
	0.1300	101.503
	0.1333	101.484
	0.1366	101.471
	0.1400	101.452
	0.1433	101.433

	0.0733	[illegible]
	0.0766	101.747
	0.0800	101.031
	0.0833	101.205
	0.0866	101.687
	0.0900	101.680
	0.0933	101.677
	0.0966	101.671
	0.1000	101.661
	0.1033	101.642
A	0.1066	101.627
	0.1100	101.608
	0.1133	101.592
	0.1166	101.573
	0.1200	101.554
	0.1233	101.538
	0.1266	101.516
	0.1300	101.503
	0.1333	101.484
	0.1366	101.471
	0.1400	101.452
	0.1433	101.433
	0.1466	101.417
	0.1500	101.401
	0.1533	101.386
	0.1566	101.367
	0.1600	101.351
	0.1633	101.335
	0.1666	101.319
	0.1700	101.303
	0.1733	101.287
	0.1766	101.272
	0.1800	101.256
	0.1833	101.240
	0.1866	101.224
	0.1900	101.208
	0.1933	101.192
	0.1966	101.180
	0.2000	101.164
	0.2033	101.148
	0.2066	101.132
	0.2100	101.119
	0.2133	101.104
	0.2166	101.091
	0.2200	101.075
	0.2233	101.062
	0.2266	101.050
	0.2300	101.034
	0.2333	101.021
	0.2366	101.008
	0.2400	100.996
	0.2433	100.980
	0.2466	100.967
	0.2500	100.955
	0.2533	100.942
	0.2566	100.929
	0.2600	100.916
	0.2633	100.904
	0.2666	100.891
	0.2700	100.882
	0.2733	100.869
	0.2766	100.856
	0.2800	100.844
	0.2833	100.834
	0.2866	100.821
	0.2900	100.809
	0.2933	100.799
	0.2966	100.786
	0.3000	100.777
	0.3033	100.764
	0.3066	100.755
B	0.3100	100.742
	0.3133	100.733

	0.2733	100.869
	0.2766	100.856
	0.2800	100.844
	0.2833	100.834
	0.2866	100.821
	0.2900	100.809
	0.2933	100.799
	0.2966	100.786
	0.3000	100.777
	0.3033	100.764
	0.3066	100.755
B	0.3100	100.742
	0.3133	100.733
	0.3166	100.723
	0.3200	100.714
	0.3233	100.701
	0.3266	100.691
	0.3300	100.682
	0.3333	100.672
	0.3500	100.618
	0.3666	100.571
	0.3833	100.526
	0.4000	100.485
	0.4166	100.447
	0.4333	100.412
	0.4500	100.377
	0.4666	100.349
	0.4833	100.320
	0.5000	100.295
	0.5166	100.270
	0.5333	100.251
	0.5500	100.228
	0.5666	100.213
	0.5833	100.193
	0.6000	100.178
	0.6166	100.165
	0.6333	100.152
	0.6500	100.140
	0.6666	100.130
	0.6833	100.121
	0.7000	100.111
	0.7166	100.102
	0.7333	100.095
	0.7500	100.089
	0.7666	100.082
	0.7833	100.076
	0.8000	100.070
	0.8166	100.067
	0.8333	100.063
	0.8500	100.057
	0.8666	100.054
	0.8833	100.051
	0.9000	100.048
	0.9166	100.044
	0.9333	100.041
	0.9500	100.038
	0.9666	100.035
	0.9833	100.035
	1.0000	100.032
	1.2000	100.016
	1.4000	100.006
	1.6000	100.003
	1.8000	100.003
	2.0000	100.000
	2.2000	100.000
	2.4000	100.000
	2.6000	100.000
	2.8000	100.000
	3.0000	100.000
	3.2000	100.000
	3.4000	99.996
C	3.6000	100.000
	3.8000	100.000

	2.4000	[illegible]
	2.6000	100.000
	2.8000	100.000
	3.0000	100.000
	3.2000	100.000
	3.4000	99.996
C	3.6000	100.000
	3.8000	100.000
	4.0000	100.000
	4.2000	100.000
	4.4000	100.000
	4.6000	100.000
	4.8000	100.000
	5.0000	100.000
	5.2000	100.000
	5.4000	100.000
	5.6000	100.000
	5.8000	99.996
	6.0000	99.996
	6.2000	99.996
	6.4000	100.000
	6.6000	100.000
	6.8000	100.000
	7.0000	100.000
	7.2000	100.000
	7.4000	100.000
	7.6000	100.000
	7.8000	100.000
	8.0000	100.000
	8.2000	100.000
	8.4000	99.996
	8.6000	100.000
	8.8000	99.996
	9.0000	100.000
	9.2000	99.996
	9.4000	99.996
	9.6000	99.996
	9.8000	100.000
	10.0000	99.996
	12.0000	100.000
	14.0000	100.000
	16.0000	100.000
	18.0000	100.000
	20.0000	100.000
	22.0000	100.000
	24.0000	100.000
	26.0000	100.000
	28.0000	100.000
	30.0000	100.000
	32.0000	100.000
	34.0000	100.000
	36.0000	100.000
	38.0000	100.000
	40.0000	100.000
	42.0000	100.000
	44.0000	100.000
	46.0000	100.000
	48.0000	100.000
	50.0000	100.000
	52.0000	100.000
	54.0000	100.000
	56.0000	100.000
	58.0000	100.000
	60.0000	100.000
	62.0000	100.000

END

D

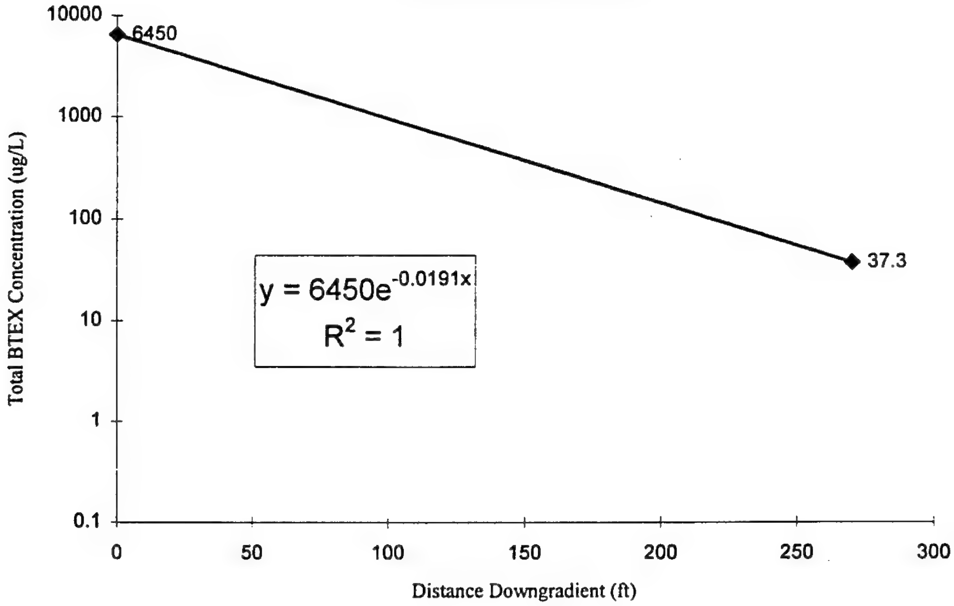
APPENDIX E

CALCULATIONS

FIRST-ORDER DECAY RATE CALCULATION
USING THE METHOD OF BUSCHECK AND ALCANTAR (1995)
Building 4522
Seymour Johnson AFB, North Carolina

Point	Distance (ft) Downgradient	BTEX Dec-98
MW4	0	6450
MW7	270	37.3

PLOT OF BTEX CONCENTRATION VERSUS DISTANCE



$$\lambda = v_c/4\alpha_x([1+2\alpha_x(k/v_x)]^2-1)$$

where	$v_c = 0.09$	ft/day
	$\alpha_x = 27$	feet
	$k/v = 0.0191$	
therefore	$\lambda = 2.61E\text{-}03$	days^{-1}
half-life =	0.7	years

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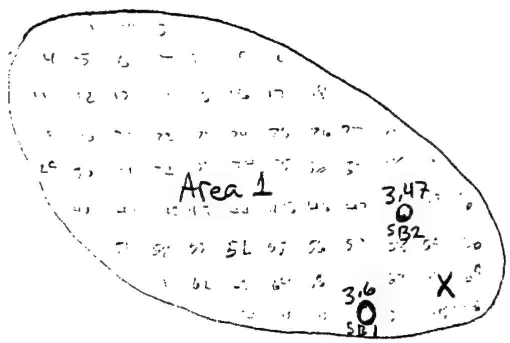
Seymour Johnson AFB 731854.05000 Tom Dragoo 4/6/99

Total Benzene mass for model

Estimated Area of Soil Contamination and Detected Benzene Levels



0' 50'

□ Area = 10 x 10 = 100 ft^2

Area 1 = 76 squares

Ave Concentration = 3.5 mg/Kg

$\boxed{\text{Area 1}}$

Area → $76 \text{ squares} \times \frac{100\ ft^2}{\text{square}} = 7{,}600\ ft^2$

Volume → $7{,}600\ ft^2 \times 7.0\ ft = 53{,}200\ ft^3$

$$53{,}200\ ft^3 \times \frac{28.32\ L}{ft^3} \times \frac{1.6\ kg}{L} \times \frac{3.5\ mg}{Kg} \times \frac{1\ Kg}{1000\ g} \times \frac{1\ g}{1000\ mg} = 8.4\ Kg$$

$\boxed{\text{8.4 Kg of total benzene mass}}$

First-Order Degradation Rate Calculations for BTEX and Benzene

Seymour Johnson AFB, North Carolina

Rates were computed using data from wells MW4 and MW7, located along the approximate center-line of the BTEX plume. The method of Buscheck and Alcantar (1995) was used.

The contaminant migration velocity (V_c)was computed as follows:

V_c = groundwater migration velocity (V_g)/retardation coefficient

V_g = Ki/n_e where K = hydraulic conductivity (ft/day), i = hydraulic gradient (ft/ft), and n_e = effective porosity. From Section 3.2, V_g = 0.24 ft/day

From Table 6.6, benzene and BTEX retardation coefficients are 1.46 and 2.66, respectively.

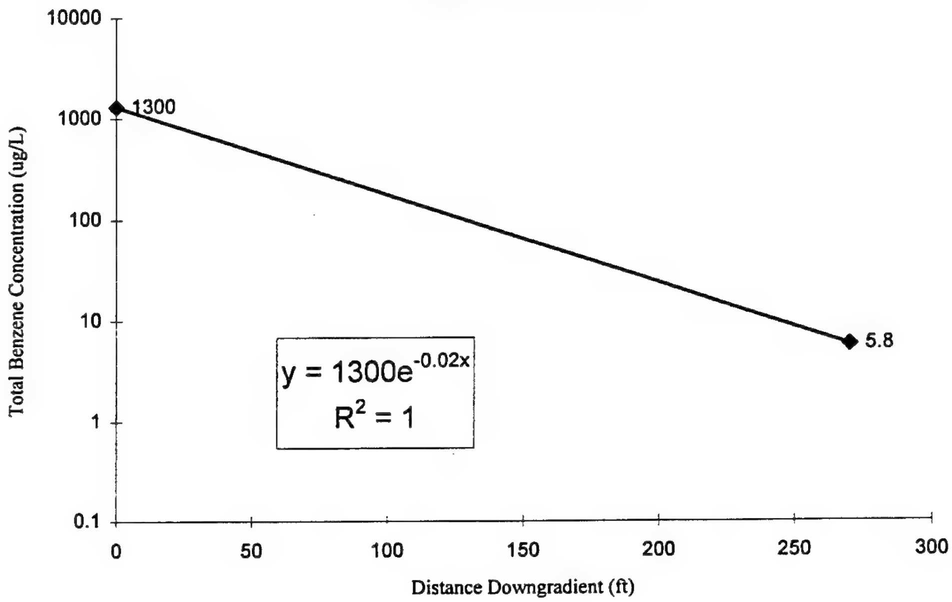
Therefore, V_c for benzene = 0.24/1.46 = 0.16 ft/day, and V_c for BTEX = 0.24/2.66 = 0.09 ft/day.

The longitudinal dispersivity (α_x) is assumed to be one-tenth the distance of the selected flowpath between MW4 and MW7, or 27 feet (Spitz and Moreno, 1996).

FIRST-ORDER DECAY RATE CALCULATION
USING THE METHOD OF BUSCHECK AND ALCANTAR (1995)
Building 4522
Seymour Johnson AFB, North Carolina

Point	Distance (ft) Downgradient	Benzene Dec-98
MW4	0	1300
MW7	270	5.8

PLOT OF BENZENE CONCENTRATION VERSUS DISTANCE



$$\lambda = v_c/4\alpha_x([1+2\alpha_x(k/v_x)]^2-1)$$

where	$v_c = 0.16$		ft/day
	$\alpha_x = 27$		feet
	$k/v = 0.02$		
therefore	$\lambda = 4.93E-03$		$days^{-1}$
half-life =		0.4	years

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TIER 2 SSTLs FOR SOIL GAS

1.1.3 Soil Vapor: Inhalation of Indoor Air Vapors

In this exposure pathway, RBSLs are calculated in soil vapor that are protective of inhalation of indoor air. Soil vapor measurements, taken very near the soil source, are then compared to the soil vapor RBSLs calculated for Tier 1.

The RBSL in soil vapor is calculated by estimating an attenuation factor that accounts for diffusion in the unsaturated zone and building foundation and dilution and mixing with the air in the building. In order to calculate the RBSL in soil vapor, an acceptable risk-based indoor air concentration is calculated first. Then the attenuation factor is applied to calculate the soil vapor concentration. The equations used to estimate the risk-based concentration in air are presented in Section 1.4. The Johnson & Ettinger (1991) model was used to calculate the attenuation factor. This model considers advection (pressure-driven vapor flow) as well as diffusion processes. Pressure-driven vapor flow arises when the basement of the building is under-pressurized relative to the surrounding soil vapor. This condition causes the soil vapor surrounding the building to be drawn into the basement by advection (with flow of air). Under-pressurization can occur when running a heater in the building.

The ASTM equations for calculating RBSLs in soil, protective of indoor air, consider diffusion only. The Johnson and Ettinger model could be considered more conservative than the diffusive only model used by ASTM. The attenuation equation (considering both advection and diffusion) are presented in section 1.4.

The assumptions made in the calculation of this RBSL are:

- The soil vapor concentration in the subsurface soil near the source is assumed to be constant and does not deplete with time (infinite source).
- No mass is lost due to degradation or leaching.
- The soil vapor migrates into the building due to pressure-driven flow and diffusive transport.
- The distribution of chemical in the various phases (sorbed, dissolved and vapor) in the unsaturated and saturated zones is assumed to follow linear, equilibrium partitioning.
- The air in the building is well mixed and can be estimated by assuming a fresh air exchange rate.
- The unsaturated zone properties are homogeneous.
- The diffusion through the building foundation is assumed to occur in soil-filled cracks in the foundation.

The input parameters that are unique to this exposure pathway are:

Fraction organic carbon	*Henry's law coefficient*	*Diffusion coefficient in air*
Soil bulk density	*Thickness of the foundation*	*Diffusion coefficient in water*
Moisture content	*Fraction of cracks*	*Ceiling height in building*
Air content	*Air content in cracks*	*Air exchange rate in building*
Distance to the building	*Water content in cracks*	*Pressure difference*
Intrinsic permeability of soil	*Distance from basement to soil vapor source*	

1.1.4 Groundwater: Inhalation of Indoor Air Vapors

Chemical Properties

	Units	Benzene	Ethyl-benzene	Toluene	Xylenes	Acenaph-thene	Acenaph-thylene	Anthra-cene
Toxicity Data:								
Slope Factor Oral	1/(mg/kg-d)	2.90E-02	ND	ND	ND	ND	ND	ND
Slope Factor Inhalation	1/(mg/kg-d)	2.90E-02	ND	ND	ND	ND	ND	ND
RfD Oral	mg/kg-d	1.70E-03	1.00E-01	2.00E-01	2.00E+00	6.00E-02	ND	3.00E-01
RfD Inhalation	mg/kg-d	1.70E-03	2.90E-01	1.14E-01	2.00E-01	6.00E-02	ND	3.00E-01
Absorption Adjustment Factor: Oral-Soil	-	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Absorption Adjustment Factor: Oral-Water	-	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Absorption Adjustment Factor: Dermal-Soil	-	5.00E-01	5.00E-01	5.00E-01	5.00E-01	5.00E-02	5.00E-02	5.00E-02
Absorption Adjustment Factor: Dermal-Water	-	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Absorption Adjustment Factor: Inhalation	-	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Fate and Transport Parameters:								
Solubility	mg/L	1.75E+03	1.69E+02	5.26E+02	1.98E+02	4.24E+00	3.93E+00	4.34E-02
Henry's Law Constant (no NDs)	-	2.28E-01	3.23E-01	2.72E-01	2.90E-01	6.36E-03	4.67E-03	2.67E-03
Koc (for organics, ND for inorganics)	ml/g	5.89E+01	3.63E+02	1.82E+02	2.40E+02	7.08E+03	4.79E+03	2.95E+04
Kd (partition coefficient for inorganics)	ml/g	ND	ND	ND	ND	ND	ND	ND
Diffusion Coeff. in Air	cm^2/s	8.80E-02	7.50E-02	8.70E-02	7.20E-02	4.21E-02	5.40E-02	3.24E-02
Diffusion Coefficient in Water	cm^2/s	9.80E-06	7.80E-06	8.60E-06	8.50E-06	7.69E-06	6.60E-06	7.74E-06
log Kow -- Octanol/Water Partition Coefficient	L/kg	2.13E+00	3.14E+00	2.75E+00	3.26E+00	3.92E+00	3.94E+00	4.55E+00
Degradation Rate in Aquifer	1/day	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.82E-02	8.20E-03	7.00E-03
Other Parameters								
CAS Number	-	71-43-2	100-41-4	108-88-3	1330-20-7	83-32-9	208-96-8	120-12-7
Molecular Weight	g/mol	78	106.2	92.10	106.2	154.2	152.2	178.2
Density	g/cm^3	0.88	0.87	8.67E-01	0.87	1.07	0.90	1.25
Vapor Pressure	mmHg	9.52E+01	9.60E+00	28.4	8.84E+00	2.30E-03	9.12E-04	2.67E-04
EPA Carcinogenic Classification		A	D	D	D	ND	D	D
Temperature	°C	20	20	20	20	20	20	20
Universal Gas Constant - R	cm^3-atm/mol-°K	82.057	82.057	82.057	82.057	82.057	82.057	82.057
Vapor Concentration at Saturated Vapor Pressure	ug/m^3	4.06E+05	5.58E+04	1.43E+05	5.14E+04	1.94E+01	7.60E+00	2.60E+00
MCL	mg/l	5.00E-03	6.80E-01	1.00E+00	1.00E+01	ND	ND	ND
Saturated Soil Concentration:								
Soil concentration at saturated conditions	mg/kg	1.12E+03	5.73E+02	9.23E+02	4.51E+02	2.70E+02	1.70E+02	1.15E+01
	Carcinogen?	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
	Hazard?	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE

References:

Fate & Transport Data

U.S. Environmental Protection Agency. 1994. Soil Screening Guidance, Office of Solid Waste and Emergency Response, EPA/540/R-94/101.

Toxicological Data

U.S. Environmental Protection Agency. 1996. Region 9 Preliminary Remediation Goals (PRGs). Region 9, San Francisco

Chemical Properties

	Units	Benz(a)-anthracene	Benzo(a)-pyrene	Benzo(b)-fluoranthene	Benzo(g,h,i)-perylene	Benzo(k)-fluoranthene	Chrysene	Dibenz(a,h)anthracene
Toxicity Data:								
Slope Factor Oral	1/(mg/kg-d)	7.30E-01	7.30E+00	7.30E-01	ND	7.30E-02	7.30E-03	7.30E+00
Slope Factor Inhalation	1/(mg/kg-d)	7.30E-01	7.30E+00	7.30E-01	ND	7.30E-02	7.30E-03	7.30E+00
RfD Oral	mg/kg-d	ND	ND	ND	ND	ND	ND	ND
RfD Inhalation	mg/kg-d	ND	ND	ND	ND	ND	ND	ND
Absorption Adjustment Factor: Oral-Soil	-	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Absorption Adjustment Factor: Oral-Water	-	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Absorption Adjustment Factor: Dermal-Soil	-	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02
Absorption Adjustment Factor: Dermal-Water	-	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Absorption Adjustment Factor: Inhalation	-	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Fate and Transport Parameters:								
Solubility	mg/L	9.40E-03	1.62E-03	1.50E-03	2.60E-04	8.00E-04	1.60E-03	2.49E-03
Henry's Law Constant (no NDs)	-	1.37E-04	4.63E-05	4.55E-03	1.09E-05	3.40E-05	3.88E-03	6.03E-07
Koc (for organics, ND for inorganics)	ml/g	3.98E+05	1.02E+06	1.23E+06	7.76E+06	1.23E+06	3.98E+05	3.80E+06
Kd (partition coefficient for inorganics)	ml/g	ND	ND	ND	ND	ND	ND	ND
Diffusion Coeff. in Air	cm^2/s	5.10E-02	4.30E-02	2.26E-02	4.10E-02	2.26E-02	2.48E-02	2.02E-02
Diffusion Coefficient in Water	cm^2/s	9.00E-06	9.00E-06	5.56E-06	4.90E-06	5.56E-06	6.21E-06	5.18E-06
log Kow -- Octanol/Water Partition Coefficient	L/kg	5.70E+00	6.11E+00	6.20E+00	7.10E+00	6.20E+00	5.70E+00	6.69E+00
Degradation Rate in Aquifer	1/day	3.40E-03	6.08E-03	9.60E-04	5.87E-04	3.90E-04	9.34E-04	9.60E-04
Other Parameters								
CAS Number	-	56-55-3	50-32-8	205-99-2	191-24-2	207-08-9	218-01-9	53-70-3
Molecular Weight	g/mol	228	252.3	252.3	276.3	252.3	228.3	278.4
Density	g/cm^3	1.27	1.35	1.35	1.35	1.35	1.27	1.28
Vapor Pressure	mmHg	3.05E-08	5.49E-09	5.00E-07	1.01E-10	9.65E-10	6.23E-09	1.00E-10
EPA Carcinogenic Classification		B2	B2	B2	D	B2	B2	B2
Temperature	°C	20	20	20	20	20	20	20
Universal Gas Constant - R	cm^3-atm/mol-°K	82.057	82.057	82.057	82.057	82.057	82.057	82.057
Vapor Concentration at Saturated Vapor Pressure	$\mu g/m^3$	3.81E-04	7.58E-05	6.90E-03	1.53E-06	1.33E-05	7.78E-05	1.52E-06
MCL	mg/l	ND	1.00E-05	ND	ND	ND	ND	ND
Saturated Soil Concentration:								
Soil concentration at saturated conditions	mg/kg	3.37E+01	1.49E+01	1.66E+01	1.82E+01	8.86E+00	5.73E+00	8.52E+01
	Carcinogen?	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE	TRUE
	Hazard?	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

References:

Fate & Transport Data

U.S. Environmental Protection Agency. 1994. Soil Screening Guidance, Office of Solid Waste and Emergency Response, EPA/540/R-94/101.

Toxicological Data

U.S. Environmental Protection Agency. 1996. Region 9 Preliminary Remediation Goals (PRGs). Region 9, San Francisco

Chemical Properties

	Units	Flouran-thene	Fluorene	Indeno-(1,2,3-CD) pyrene	Naphthalene	Phenan-threne	Pyrene
Toxicity Data:							
Slope Factor Oral	1/(mg/kg-d)	ND	ND	7.30E-01	ND	ND	ND
Slope Factor Inhalation	1/(mg/kg-d)	ND	ND	7.30E-01	ND	ND	ND
RfD Oral	mg/kg-d	4.00E-02	4.00E-02	ND	4.00E-02	ND	3.00E-02
RfD Inhalation	mg/kg-d	4.00E-02	4.00E-02	ND	4.00E-02	ND	3.00E-02
Absorption Adjustment Factor: Oral-Soil	-	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Absorption Adjustment Factor: Oral-Water	-	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Absorption Adjustment Factor: Dermal-Soil	-	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02
Absorption Adjustment Factor: Dermal-Water	-	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Absorption Adjustment Factor: Inhalation	-	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Fate and Transport Parameters:							
Solubility	mg/L	2.06E-01	1.98E+00	2.20E-05	3.10E+01	1.29E+00	1.35E-01
Henry's Law Constant (no NDs)	-	6.60E-04	2.61E-03	6.56E-05	1.98E-02	1.60E-03	4.51E-04
Koc (for organics, ND for inorganics)	ml/g	1.07E+05	1.38E+04	3.47E+06	2.00E+03	2.29E+04	1.05E+05
Kd (partition coefficient for inorganics)	ml/g	ND	ND	ND	ND	ND	ND
Diffusion Coeff. in Air	cm^2/s	3.02E-02	3.63E-02	1.90E-02	5.90E-02	5.17E-02	2.72E-02
Diffusion Coefficient in Water	cm^2/s	6.35E-06	7.88E-06	5.66E-06	7.50E-06	5.90E-06	7.24E-06
log Kow – Octanol/Water Partition Coefficient	L/kg	5.12E+00	4.21E+00	6.65E+00	3.36E+00	4.57E+00	5.11E+00
Degradation Rate in Aquifer	1/day	2.50E-03	1.10E-02	5.80E-04	7.00E-01	2.20E-02	1.70E-03
Other Parameters							
CAS Number	-	206-44-0	86-73-7	193-39-5	91-20-3	85-01-8	129-00-0
Molecular Weight	g/mol	202.3	166.2	276.3	128.2	178.2	202.3
Density	g/cm^3	1.25	1.20	1.35	1.16	1.18	1.27
Vapor Pressure	mmHg	1.23E-08	8.42E-03	1.00E-10	8.50E-02	1.12E-04	2.45E-06
EPA Carcinogenic Classification		D	D	B2	D	D	D
Temperature	°C	20	20	20	20	20	20
Universal Gas Constant - R	cm^3-atm/mol-°K	82.057	82.057	82.057	82.057	82.057	82.057
Vapor Concentration at Saturated Vapor Pressure	ug/m^3	1.36E-04	7.66E+01	1.51E-06	5.96E+02	1.09E+00	2.71E-02
MCL	mg/l	ND	ND	ND	ND	ND	ND
Saturated Soil Concentration:							
Soil concentration at saturated conditions	mg/kg	1.98E+02	2.46E+02	6.87E-01	5.60E+02	2.66E+02	1.28E+02

Carcinogen?	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE
Hazard?	TRUE	TRUE	FALSE	TRUE	FALSE	TRUE

References:

Fate & Transport Data

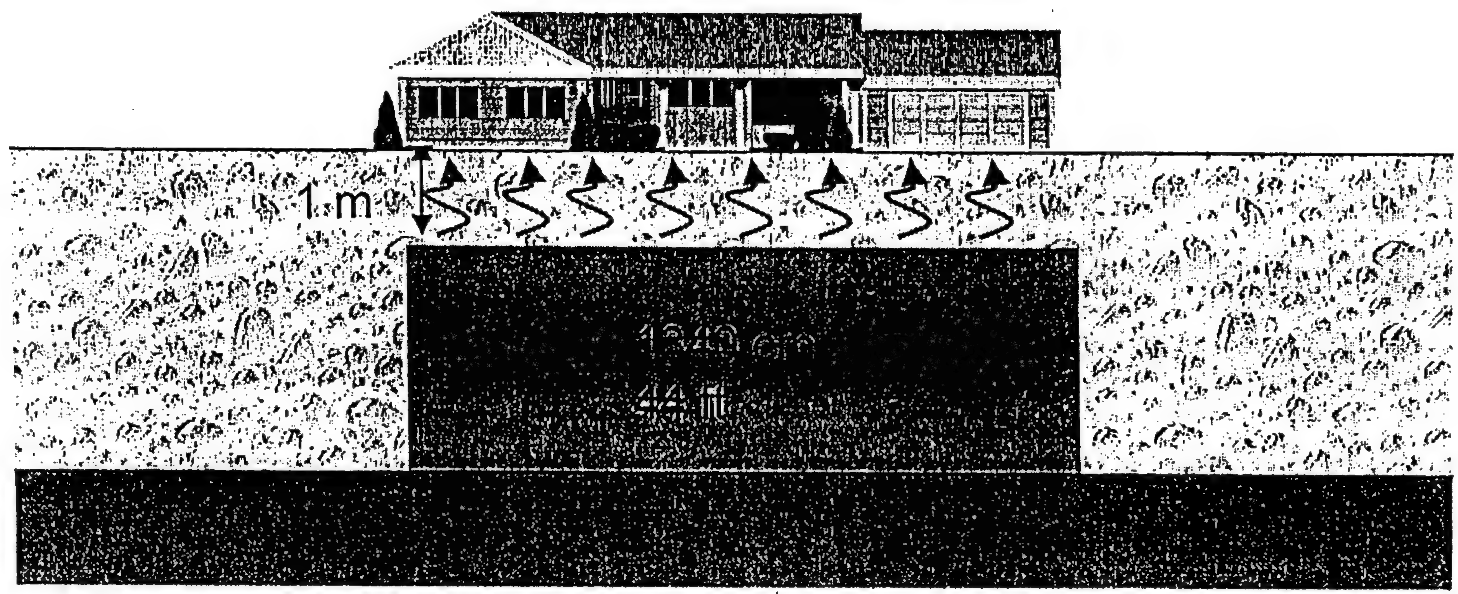
U.S. Environmental Protection Agency. 1994. Soil Screening Guidance, Office of Solid Waste and Emergency Response, EPA/540/R-94/101.

Toxicological Data

U.S. Environmental Protection Agency. 1996. Region 9 Preliminary Remediation Goals (PRGs). Region 9, San Francisco

Exposure Pathways:
Soil Vapor to Indoor Air

- Protective of inhalation of indoor air.
- RBSLs calculated for soil vapor rather than in soil.



Input Parameters

SITE INFORMATION:	Enter values in unshaded cells only
Site Name	ACME Petroleum Sales
Site Address	4321 Broadway Blvd., Springfield

		Risk Scenario		
		Residential/ Commercial		Industrial
TARGET RISK LEVELS:	Units	Value for ADULT	Value for CHILD	Value for Industrial
Target risk	unitless	1.0E-06	*= adult res.*	1.0E-06
Target hazard quotient	unitless	1.0	*= adult res.*	1.0

		Residential/ Commercial		Industrial
EXPOSURE PARAMETERS	Units	Value for ADULT	Value for CHILD	Value for Industrial
Averaging Time for Carcinogens	yr	70	= adult res.	= adult res.
Averaging Time for Non-Carcinogens	yr	24	6	30
Body Weight	kg	70	15	70
Exposure duration	yr	24	6	25
Exposure frequency	d/yr	350	350	250
Exposure time for indoor air	hr/d	24	24	8
Exposure time for outdoor air	hr/d	8	8	8
Soil Ingestion rate	mg/d	100	200	50
Daily indoor inhalation rate	m^3/d	15	15	20
Daily outdoor inhalation rate	m^3/d	20	15	20
Daily water ingestion rate	L/d	2	2	1
Soil to skin adherence factor	mg/cm^2	0.5	0.5	0.5
Skin surface area for soil exposure	cm^2	3160	2190	3160

Input Parameters

SATURATED ZONE PARAMETERS: (Domenico Model)	Units	Residential/ Commercial Value for ADULT	Residential/ Commercial Value for CHILD	Industrial Value for Industrial
Groundwater Darcy Velocity	cm/yr	1800	*=adult res.*	*=adult res.*
Groundwater mixing zone thickness	cm	200	*=adult res.*	*=adult res.*
Distance downgradient	cm	1000	*=adult res.*	*=adult res.*
Effective porosity in aquifer	cm^3/cm^3	0.25	*=adult res.*	*=adult res.*
Length of source area parallel to wind or groundwater flow direction	cm	1000	*=adult res.*	*=adult res.*
Width of source perpendicular to direction of groundwater flow	cm	1000	*=adult res.*	*=adult res.*
Longitudinal dispersivity Calculated from distance (= 0.10*X)	cm	100	*=adult res.*	*=adult res.*
Transverse dispersivity Calculated from distance (= alphaX/3)	cm	33	*=adult res.*	*=adult res.*
Vertical dispersivity Calculated from distance (= alphaX/20)	cm	5	*=adult res.*	*=adult res.*

UNSATURATED ZONE PARAMETERS:	Units	Residential/ Commercial Value for ADULT	Residential/ Commercial Value for CHILD	Industrial Value for Industrial
Lower depth of surficial soil	cm	100.0	*=adult res.*	*=adult res.*
Fraction organic carbon	g oc/g soil	0.009	*=adult res.*	*=adult res.*
Infiltration rate	cm/yr	5	*=adult res.*	*=adult res.*
Distance between foundation and soil vapor source	cm	100	*=adult res.*	*=adult res.*
Volumetric air content in unsaturated zone	cm^3/cm^3	0.26	*=adult res.*	*=adult res.*
Total soil porosity unsaturated zone	cm^3/cm^3	0.38	*=adult res.*	*=adult res.*
Volumetric water content in unsaturated zone	cm^3/cm^3	0.12	*=adult res.*	*=adult res.*
Soil bulk density	g/cm^3	1.64	*=adult res.*	*=adult res.*

Input Parameters

VOLATILIZATION FROM GROUNDWATER:	Units	Residential/ Commercial Value for ADULT	Residential/ Commercial Value for CHILD	Industrial Value for Industrial
Depth to groundwater (Hcap+Hv)	cm	380	*=adult res.*	*=adult res.*
Volumetric air content in capillary fringe soils	cm^3/cm^3	0.038	*=adult res.*	*=adult res.*
Volumetric water content in capillary fringe	cm^3/cm^3	0.342	*=adult res.*	*=adult res.*
Thickness of capillary fringe	cm	5	*=adult res.*	*=adult res.*
Thickness of unstaturated zone	cm	375	*=adult res.*	*=adult res.*

OUTDOOR AND INDOOR VOLATILIZATION/BUILDING PARAMETERS:	Units	Residential/ Commercial Value for ADULT	Residential/ Commercial Value for CHILD	Industrial Value for Industrial
Air exchange rate with outside air	1/s	1.40E-04	*=adult res.*	2.30E-04
Enclosed-space volume/infiltration area ratio	cm	200	*=adult res.*	488
Enclosed-space foundation or wall thickness	cm	15	*=adult res.*	15
Areal fraction of cracks in foundations/walls	cm^2/cm^2	0.01	*=adult res.*	0.01
Vol. air content in foundation/wall cracks	cm^3/cm^3	0.26	*=adult res.*	*=adult res.*
Vol. water content in foundation/wall cracks	cm^3/cm^3	0.12	*=adult res.*	*=adult res.*
Particulate emission rate	g/cm^2-s	6.90E-14	*=adult res.*	6.9E-14
Wind speed above ground surface in ambient mixing zone	cm/s	370	*=adult res.*	=adult res.
Ambient air mixing zone height	cm	200	*=adult res.*	*=adult res.*
Length of source area parallel to wind or groundwater flow direction	cm	1000	*=adult res.*	*=adult res.*

OUTDOOR AND INDOOR SOIL GAS PARAMETERS:	Units	Residential/ Commercial Value for ADULT	Residential/ Commercial Value for CHILD	Industrial Value for Industrial
Total building area	cm^2	7.40E+05	*=adult res.*	1.16E+06
Building volume including basement of crawl space	cm^3	3.60E+08	*=adult res.*	5.60E+08
Building under-pressurization	$g/cm\text{-}sec^2$	1.00E+01	*=adult res.*	*=adult res.*
Air viscosity	g/cm-sec	1.80E-04	*=adult res.*	*=adult res.*
Total floor-wall seam perimeter distance	cm	3.70E+03	*=adult res.*	4.60E+03
Distance below ground surface of the basement cracks	cm	244	*=adult res.*	*=adult res.*
Soil air permeability	cm^2	1.00E-08	*=adult res.*	*=adult res.*

TIER 2 SSTLs FOR SOIL

CHEMICAL PROPERTIES FOR CONTAMINANTS
BUILDING 4522
SEYMOUR JOHNSON AFB, NORTH CAROLINA

			Chemical Properties [a]																				
Contaminant	CAS Number [b]	Type [c]	t^* (hr) [d]	Ref [e]	K_p (cm/hr) [f]	Ref	t_{event} (hr/event) [g]	Ref	B (unitless)	Ref	OAF	Ref	Sf_{oral} $(mg/kg\text{-}day)^{-1}$ [h]	Ref	SF_d $(mg/kg\text{-}day)^{-1}$	RfD_{oral} (mg/kg-day)	Ref	RfD_d (mg/kg-day)	URF $(\mu g/m^3)$ [i]	Ref	RfC $(\mu g/m^3)$	Ref
Volatile Organic Compounds																						
Benzene	71-43-2	o	6.30E-01	D	2.10E-02	D	2.60E-01	D	1.30E-02	D	0.97	1	2.90E-02	I	2.99E-02	3.00E-03	E	2.91E-03	7.80E-06	I	5.95E+00	E

[a] Chemical Properties are defines as follows: t^* = time it takes to reach steady state, K_p = Permeability coefficient from water, t_{event} = lag time per event, B = Relative contribution of permeability coefficients, OAF = oral absorption factor, SForal
SF_d = dermal slope factor (i.e., oral slope factor adjusted for gastrintestinal absorption), RFDoral = oral reference dose, RFDd = dermal reference dose (i.e., oral referenc dose adjusted for gastrointestinal absorption), URF = inhalation unit risk fac
RfC = inhalation reference concentration.

[b] CAS = Chemical Abstracts Service number.

[c] "o" indicates an organic compound, "i" indicates an inorganic compound

[d] hr = hour

[e] Ref = References as defined below.

[f] cm/hr = centimeters per hour

[g] hr/event = hours per event

[h] mg/kg-day = milligrams per kilogram-day

[i] $\mu g/m^3$ = micrograms per cubic meter

[j] -- = toxicity data were not available.

References:
C = Calculated per USEPA (1992)
D = USEPA (1992) Dermal Exposure Assessmant: Principles and Applications .
E = USEPA National Center for Environmental Assessment per USEPA Region 3 (1998).
I = USEPA (1999), Integrated Risk Information System (IRIS).
O = Other per USEPA Region 3 (1998)
1 = Taken from Bast and Borges. 1996. Derivation of toxicity values for dermal exposure. *The Toxicologist*. 30(2):152. 1998 Update.

SITE-SPECIFIC TARGET LEVEL CALCULATIONS - SOIL [a]
INDUSTRIAL LAND USE - CONSTRUCTION SCENARIO
BUILDING 4522
SEYMOUR JOHNSON AFB, NORTH CAROLINA

Exposure Assumptions		
Receptor	Construction Worker	
Site-specific target level for combined exposure routes (SSTL)	chem.-specific	mg/kg [b]
Site-specific target level based on soil ingestion ($SSTL_{ing}$)	chem.-specific	mg/kg
Site-specific target level based on dermal contact with soil ($SSTL_{derm}$)	chem.-specific	mg/kg
Site-specific target level: inhalation of volatiles/particulates from soil ($SSTL_{inh}$)	chem.-specific	mg/kg

SSTL Equations (combined exposure routes)

$$SSTL = \frac{1}{\frac{1}{SSTL_{ing}} + \frac{1}{SSTL_{derm}} + \frac{1}{SSTL_{inhal}}}$$

		RME SCENARIO [d]				CT SCENARIO [e]			
Contaminant	CAS Number [c]	$SSTL_{ing}$ (mg/kg)	$SSTL_{derm}$ (mg/kg)	$SSTL_{inhal}$ (mg/kg)	$SSTL_{RME}$ (mg/kg)	$SSTL_{ing}$ (mg/kg)	$SSTL_{derm}$ (mg/kg)	$SSTL_{inhal}$ (mg/kg)	$SSTL_{CT}$ (mg/kg)
Volatile Organic Compounds									
Benzene	71-43-2	7.14E+02	--	3.29E+01	**3.14E+01**	5.14E+03	--	9.86E+01	9.67E+01

[a] SSTL calculations based on combining the following exposure routes: incidental ingestion, dermal contact, and inhalation of volatiles/particulates from soil.

[b] mg/kg = milligram per kilogram

[c] CAS = Chemical Abstracts Service number.

[d] RME = reasonable maximum exposure

[e] CT = central tendency

[f] "--" = dermal absorption for volatiles in soils assumed to be insignificant (USEPA, 1992).

[g] "***" = toxicity data not available for specified route of exposure.

SITE-SPECIFIC TARGET LEVEL CALCULATIONS BASED ON SOIL INGESTION
INDUSTRIAL LAND USE - CONSTRUCTION SCENARIO - RME SCENARIO
BUILDING 4522
SEYMOUR JOHNSON AFB, NORTH CAROLINA

Exposure Assumptions		
Receptor	Construction Worker: RME Scenario	
Site-specific target level based on soil ingestion ($SSTL_{ing}$)	chemical-specific	mg/kg [a]
Target cancer risk level (TR)	1.00E-06	unitless
Body Weight (BW)	70	kg
Averaging Time, Carcinogens (AT_c)	70	yrs
Oral Slope Factor (SF_o)	chemical-specific	$(mg/kg\text{-}day)^{-1}$ [b]
Soil Ingestion Rate (IR_{soil})	480	mg/day
Exposure Frequency (EF)	180	days/yr
Exposure Duration (ED)	1	yr
Fraction Contaminated Soil Ingested (FI)	1	unitless
Conversion Factor (CF)	0.000001	kg/mg
Target hazard quotient (THQ)	1	unitless
Oral Reference Dose (RfD_o)	chemical-specific	mg/kg-day
Averaging Time, Noncarcinogens (AT_{nc})	1	yr

SSTL Equations

Carcinogenic:

$$SSTL_{ing-c} = \frac{(TR)(BW)(AT_c)(365day/year)}{(SF_o)(IR_{soil})(EF)(ED)(FI)(CF)}$$

Noncarcinogenic:

$$SSTL_{ing-nc} = \frac{(THQ)(BW)(RfD_o)(AT_{nc})(365day/year)}{(IR_{soil})(EF)(ED)(FI)(CF)}$$

Contaminant	CAS Number[c]	SF_o $(mg/kg\text{-}day)^{-1}$	RfD_o (mg/kg-day)	$SSTL_{ing-c}$ (mg/kg)	$SSTL_{ing-nc}$ (mg/kg)	$SSTL_{ing}$ (mg/kg)
Volatile Organic Compounds						
Benzene	71-43-2	2.90E-02	3.00E-03	7.14E+02	8.87E+02	7.14E+02

[a] mg/kg = milligram per kilogram

[b] mg/kg-day = milligram per kilogram per day

[c] CAS = Chemical Abstracts Service number.

[d] -- = toxicity data not available.

SITE-SPECIFIC TARGET LEVEL CALCULATIONS BASED ON SOIL INGESTION
INDUSTRIAL LAND USE - CONSTRUCTION SCENARIO - CT SCENARIO
BUILDING 4522
SEYMOUR JOHNSON AFB, NORTH CAROLINA

Exposure Assumptions		
Receptor	Construction Worker: CT Scenario	
Site-specific target level based on soil ingestion ($SSTL_{ing}$)	chemical-specific	mg/kg [a]
Target cancer risk level (TR)	1.00E-06	unitless
Body Weight (BW)	70	kg
Averaging Time, Carcinogens (AT_c)	70	yrs
Oral Slope Factor (SF_o)	chemical-specific	$(mg/kg\text{-}day)^{-1}$ [b]
Soil Ingestion Rate (IR_{soil})	200	mg/day
Exposure Frequency (EF)	60	days/yr
Exposure Duration (ED)	1	yr
Fraction Contaminated Soil Ingested (FI)	1	unitless
Conversion Factor (CF)	0.000001	kg/mg
Target hazard quotient (THQ)	1	unitless
Oral Reference Dose (RfD_o)	chemical-specific	mg/kg-day
Averaging Time, Noncarcinogens (AT_{nc})	1	yr

SSTL Equations

Carcinogenic:

$$SSTL_{ing-c} = \frac{(TR)(BW)(AT_c)(365day/year)}{(SF_o)(IR_{soil})(EF)(ED)(FI)(CF)}$$

Noncarcinogenic:

$$SSTL_{ing-nc} = \frac{(THQ)(BW)(RfD_o)(AT_{nc})(365day/year)}{(IR_{soil})(EF)(ED)(FI)(CF)}$$

Contaminant	CAS Number [c]	SF_o $(mg/kg\text{-}day)^{-1}$	RfD_o (mg/kg-day)	$SSTL_{ing-c}$ (mg/kg)	$SSTL_{ing-nc}$ (mg/kg)	$SSTL_{ing}$ (mg/kg)
Volatile Organic Compounds						
Benzene	71-43-2	2.90E-02	3.00E-03	5.14E+03	6.39E+03	5.14E+03

[a] mg/kg = milligram per kilogram
[b] mg/kg-day = milligram per kilogram per day
[c] CAS = Chemical Abstracts Service number.
[d] -- = toxicity data not available.

SITE-SPECIFIC TARGET LEVEL CALCULATIONS BASED ON DERMAL CONTACT WITH SOIL
INDUSTRIAL LAND USE - CONSTRUCTION SCENARIO - RME SCENARIO
BUILDING 4522
SEYMOUR JOHNSON AFB, NORTH CAROLINA

Exposure Assumptions	
Receptor	Construction Worker: RME Scenario
Site-specific target level based on dermal contact with soil ($SSTL_{derm}$)	chemical-specific mg/kg [a/]
Target cancer risk level (TR)	1.00E-06 unitless
Body Weight (BW)	70 kg
Averaging Time, Carcinogens (AT_c)	70 yrs
Dermal Slope Factor (SF_d) (i.e., SF_o adjusted for GI absorption)	chemical-specific $(mg/kg\text{-}day)^{-1}$ [b/]
Exposure Frequency (EF)	180 days/yr
Exposure Duration (ED)	1 yr
Exposed Body Surface Area (SA)	5300 cm^2 [c/]
Soil-to-Skin Adherence Fraction (AF)	1 mg/cm^2-day
Dermal Soil Absorption Fraction (DAF)	chemical-specific unitless
Conversion Factor (CF)	0.000001 kg/mg
Target hazard quotient (THQ)	1 unitless
Dermal Reference Dose (RfD_d) (i.e., RfD_o adjusted for GI absorption)	chemical-specific mg/kg-day
Averaging Time, Noncarcinogens (AT_{nc})	1 yr

SSTL Equations

Carcinogenic:

$$SSTL_{derm-c} = \frac{(TR)(BW)(AT_c)(365 day/year)}{(SF_d)(EF)(ED)(SA)(AF)(DAF)(CF)}$$

$$where\ SF_d = \frac{(SF_o)}{(OAF)}$$ and: OAF = Oral GI absorption factor (chemical-specific; unitless)

Noncarcinogenic:

$$SSTL_{derm-nc} = \frac{(THQ)(BW)(RfD_d)(AT_{nc})(365 day/year)}{(EF)(ED)(SA)(AF)(DAF)(CF)}$$

$$where\ RfD_d = (RfD_o)(OAF)$$

Contaminant	CAS Number [d/]	SF_o $(mg/kg\text{-}day)^{-1}$	RfD_o (mg/kg-day)	OAF (unitless)	SF_d $(mg/kg\text{-}day)^{-1}$	RfD_d (mg/kg-day)	DAF [e/] (unitless)	$SSTL_{derm-c}$ (mg/kg)	$SSTL_{derm-nc}$ (mg/kg)	$SSTL_{derm}$ (mg/kg)
Volatile Organic Compounds										
Benzene	71-43-2	2.90E-02	3.00E-03	9.70E-01	2.99E-02	2.91E-03	--	--	--	--

[a/] mg/kg = milligram per kilogram

[b/] mg/kg-day = milligram per kilogram per day

[c/] cm^2 = square centimeter

[d/] CAS = Chemical Abstracts Service number.

[e/] DAFs for PAHs taken from Wester *et al.* (1990).

[f/] -- = toxicity data not available.

SITE-SPECIFIC TARGET LEVEL CALCULATIONS BASED ON DERMAL CONTACT WITH SOIL
INDUSTRIAL LAND USE - CONSTRUCTION SCENARIO - CT SCENARIO
BUILDING 4522
SEYMOUR JOHNSON AFB, NORTH CAROLINA

Exposure Assumptions		
Receptor	Construction Worker: CT Scenario	
Site-specific target level based on dermal contact with soil ($SSTL_{derm}$)	chemical-specific	mg/kg [a]
Target cancer risk level (TR)	1.00E-06	unitless
Body Weight (BW)	70	kg
Averaging Time, Carcinogens (AT_c)	70	yrs
Dermal Slope Factor (SF_d) (i.e., SF_o adjusted for GI absorption)	chemical-specific	$(mg/kg\text{-}day)^{-1}$ [b]
Exposure Frequency (EF)	60	days/yr
Exposure Duration (ED)	1	yr
Exposed Body Surface Area (SA)	3160	cm^2 [c]
Soil-to-Skin Adherence Fraction (AF)	0.2	mg/cm^2-day
Dermal Soil Absorption Fraction (DAF)	chemical-specific	unitless
Conversion Factor (CF)	0.000001	kg/mg
Target hazard quotient (THQ)	1	unitless
Dermal Reference Dose (RfD_d) (i.e., RfD_o adjusted for GI absorption)	chemical-specific	mg/kg-day
Averaging Time, Noncarcinogens (AT_{nc})	1	yr

SSTL Equations

Carcinogenic:

$$SSTL_{derm-c} = \frac{(TR)(BW)(AT_c)(365 day/year)}{(SF_d)(EF)(ED)(SA)(AF)(DAF)(CF)}$$

where $SF_d = \frac{(SF_o)}{(OAF)}$ and: OAF = Oral GI absorption factor (chemical-specific; unitless)

Noncarcinogenic:

$$SSTL_{derm-nc} = \frac{(THQ)(BW)(RfD_d)(AT_{nc})(365 day/year)}{(EF)(ED)(SA)(AF)(DAF)(CF)}$$

where $RfD_d = (RfD_o)(OAF)$

Contaminant	CAS Number [d]	SF_o $(mg/kg\text{-}day)^{-1}$	RfD_o (mg/kg-day)	OAF (unitless)	SF_d $(mg/kg\text{-}day)^{-1}$	RfD_d (mg/kg-day)	DAF [e] (unitless)	$SSTL_{derm-c}$ (mg/kg)	$SSTL_{derm-nc}$ (mg/kg)	$SSTL_{derm}$ (mg/kg)
Volatile Organic Compounds										
Benzene	71-43-2	2.90E-02	3.00E-03	9.70E-01	2.99E-02	2.91E-03	--	--	--	--

[a] mg/kg = milligram per kilogram

[b] mg/kg-day = milligram per kilogram per day

[c] cm^2 = square centimeter

[d] CAS = Chemical Abstracts Service number.

[e] DAFs for PAHs taken from Wester *et al.* (1990).

[f] -- = toxicity data not available.

SITE-SPECIFIC TARGET LEVEL CALCULATIONS BASED ON INHALATION OF VOLATILES/PARTICULATES FROM SOIL
INDUSTRIAL LAND USE - CONSTRUCTION SCENARIO - RME SCENARIO
BUILDING 4522
SEYMOUR JOHNSON AFB, NORTH CAROLINA

Exposure Assumptions	
Receptor	Construction Worker: RME Scenario
Site-specific target level: inhalation of volatiles/particulates from soil ($SSTL_{inh}$)	chemical-specific mg/kg [a]
Target cancer risk level (TR)	1.00E-06 unitless
Averaging Time, Carcinogens (AT_c)	70 yrs
Inhalation unit risk factor (URF)	chemical-specific $(\mu g/m^3)^{-1}$ [b]
Exposure Frequency (EF)	180 days/yr
Exposure Duration (ED)	1 yr
Fraction of time breathing contaminated air during a 24 hour day (FT)	1 unitless
Conversion Factor (CF)	1.00E+03 $\mu g/mg$
Soil-to-air volatilization factor (VF)	chemical-specific m^3/kg
Soil-to-air particulate emission factor (PEF)	1.24E+09 m^3/kg
Target hazard quotient (THQ)	1 unitless
Inhalation reference concentration (RfC)	chemical-specific $\mu g/m^3$
Averaging Time, Noncarcinogens (AT_{nc})	1 yr
Soil saturation limit (C_{sat})	chemical-specific mg/kg

SSTL Equations

Carcinogenic:

$$SSTL_{inh-c} = \frac{(TR)(AT_c)(365\,day/year)}{(URF)(EF)(ED)(FT)(CF)\left(\frac{1}{VF}+\frac{1}{PEF}\right)}$$

Noncarcinogenic:

$$SSTL_{inh-nc} = \frac{(THQ)(RfC)(AT_{nc})(365\,day/year)}{(EF)(ED)(FT)(CF)\left(\frac{1}{VF}+\frac{1}{PEF}\right)}$$

Note: If $SSTL_{inh-c}$ and $SSTL_{inh-nc}$ are > C_{sat}, $SSTL_{inh}$ = C_{sat}

Contaminant	CAS Number [c]	Chemical Type [d]	URF $(\mu g/m^3)^{-1}$	RfC $(\mu g/m^3)$	VF (m^3/kg)	$SSTL_{inh-c}$ (mg/kg)	$SSTL_{inh-nc}$ (mg/kg)	C_{sat} (mg/kg)	$SSTL_{inh}$ (mg/kg)
Volatile Organic Compounds									
Benzene	71-43-2	o	7.80E-06	5.95E+00	2.72E+03	4.96E+01	3.29E+01	8.60E+02	3.29E+01

[a] mg/kg = milligram per kilogram
[b] $\mu g/m^3$ = micrograms per cubic meter
[c] CAS = Chemical Abstracts Service number.
[d] "o" = organic chemical; "i" = inorganic chemical
[e] -- = toxicity data not available.

SITE-SPECIFIC TARGET LEVEL CALCULATIONS BASED ON INHALATION OF VOLATILES/PARTICULATES FROM SOIL
INDUSTRIAL LAND USE - CONSTRUCTION SCENARIO - CT SCENARIO
BUILDING 4522
SEYMOUR JOHNSON AFB, NORTH CAROLINA

Exposure Assumptions		
Receptor	Construction Worker:	CT Scenario
Site-specific target level: inhalation of volatiles/particulates from soil ($SSTL_{inh}$)	chemical-specific	mg/kg [a]
Target cancer risk level (TR)	1.00E-06	unitless
Averaging Time, Carcinogens (AT_c)	70	yrs
Inhalation unit risk factor (URF)	chemical-specific	$(\mu g/m^3)^{-1}$ [b]
Exposure Frequency (EF)	60	days/yr
Exposure Duration (ED)	1	yr
Fraction of time breathing contaminated air during a 24 hour day (FT)	1	unitless
Conversion Factor (CF)	1.00E+03	$\mu g/mg$
Soil-to-air volatilization factor (VF)	chemical-specific	m^3/kg
Soil-to-air particulate emission factor (PEF)	1.24E+09	m^3/kg
Target hazard quotient (THQ)	1	unitless
Inhalation reference concentration (RfC)	chemical-specific	$\mu g/m^3$
Averaging Time, Noncarcinogens (AT_{nc})	1	yr
Soil saturation limit (C_{sat})	chemical-specific	mg/kg

SSTL Equations

Carcinogenic:

$$SSTL_{inh-c} = \frac{(TR)(AT_c)(365\,day/year)}{(URF)(EF)(ED)(FT)(CF)\left(\frac{1}{VF}+\frac{1}{PEF}\right)}$$

Noncarcinogenic:

$$SSTL_{inh-nc} = \frac{(THQ)(RfC)(AT_{nc})(365\,day/year)}{(EF)(ED)(FT)(CF)\left(\frac{1}{VF}+\frac{1}{PEF}\right)}$$

Note: If $SSTL_{inh-c}$ and $SSTL_{inh-nc}$ are > C_{sat}, $SSTL_{inh}$ = C_{sat}

Contaminant	CAS Number [c]	Chemical Type [d]	URF $(\mu g/m^3)^{-1}$	RfC $(\mu g/m^3)$	VF (m^3/kg)	$SSTL_{inh-c}$ (mg/kg)	$SSTL_{inh-nc}$ (mg/kg)	C_{sat} (mg/kg)	$SSTL_{inh}$ (mg/kg)
Volatile Organic Compounds									
Benzene	71-43-2	o	7.80E-06	5.95E+00	2.72E+03	1.49E+02	9.86E+01	8.60E+02	9.86E+01

[a] mg/kg = milligram per kilogram

[b] $\mu g/m^3$ = micrograms per cubic meter

[c] CAS = Chemical Abstracts Service number.

[d] "o" = organic chemical; "i" = inorganic chemical

[e] -- = toxicity data not available.

TIER 2 SSTLs FOR GROUNDWATER

SITE-SPECIFIC TARGET LEVEL CALCULATIONS - GROUNDWATER [a/]
INDUSTRIAL LAND USE - CONSTRUCTION SCENARIO
BUILDING 4522
SEYMOUR JOHNSON AFB, NORTH CAROLINA

Exposure Assumptions		
Receptor	Construction Worker	
Site-specific target level for combined exposure routes (SSTL)	chem.-specific	μg/L [b/]
Site-specific target level based on incidental ingestion of groundwater ($SSTL_{ing}$)	chem.-specific	μg/L
Site-specific target level based on dermal contact with groundwater ($SSTL_{derm}$)	chem.-specific	μg/L
Site-specific target level based on aboveground inhalation of contaminants volatilized from groundwater ($SSTL_{inh\text{-}above}$)	chem.-specific	μg/L
Site-specific target level based on inhalation of contaminants volatilized from groundwater into the trench ($SSTL_{inh\text{-}trench}$)	chem.-specific	μg/L

SSTL Equation (combined exposure routes)

$$SSTL = \frac{1}{\frac{1}{SSTL_{ing}} + \frac{1}{SSTL_{derm}} + \frac{1}{SSTL_{inhal-above}} + \frac{1}{SSTL_{inhal-trench}}}$$

Contaminant	CAS Number [c/]	RME SCENARIO [d/] $SSTL_{ing}$ (μg/L)	$SSTL_{derm}$ (μg/L)	$SSTL_{inhal\text{-}above}$ (μg/L)	$SSTL_{inhal\text{-}trench}$ (μg/L)	$SSTL_{RME}$ (μg/L)	CT SCENARIO [e/] $SSTL_{ing}$ (μg/L)	$SSTL_{derm}$ (μg/L)	$SSTL_{inhal\text{-}above}$ (μg/L)	$SSTL_{inhal\text{-}trench}$ (μg/L)	$SSTL_{CT}$ (μg/L)
Volatile Organic Compounds											
Benzene	71-43-2	1.34E+05	5.86E+03	1.21E+06	3.31E+04	**4.78E+03**	1.64E+06	4.63E+04	3.60E+06	1.01E+05	**3.09E+04**

[a/] SSTL calculations based on combining the following exposure routes: incidental ingestion, dermal contact, inhalation of contaminates volatilized from groundwater into aboveground ambient air, and inhalation of contaminants volatilized from groundwater into ambient air in a trench/excavation pit.

[c/] CAS = Chemical Abstracts Service number.

[b/] μg/L = micrograms per liter

[d/] RME = reasonable maximum exposure

[e/] CT = central tendency

[f/] "--" = toxicity data not available for specified route of exposure.

SITE-SPECIFIC TARGET LEVEL CALCULATIONS BASED ON INCIDENTAL INGESTION OF GROUNDWATER
INDUSTRIAL LAND USE - CONSTRUCTION SCENARIO - RME SCENARIO
BUILDING 4522
SEYMOUR JOHNSON AFB, NORTH CAROLINA

Exposure Assumptions		
Receptor	Construction Worker: RME Scenario	
Site-specific target level based on incidental ingestion of groundwater ($SSTL_{ing}$)	chemical-specific	µg/L [a]
Target cancer risk level (TR)	1.00E-06	unitless
Body Weight (BW)	70	kg
Averaging Time, Carcinogens (AT_c)	70	yrs
Oral Slope Factor (SF_o)	chemical-specific	$(mg/kg\text{-}day)^{-1}$ [b]
Water Ingestion Rate (IR_w)	0.005	L/hr
Exposure Frequency (EF)	46	days/yr
Exposure Duration (ED)	1	yr
Exposure Time (ET)	2	hr/day
Conversion Factor (CF)	0.001	mg/µg
Target hazard quotient (THQ)	1	unitless
Oral Reference Dose (RfD_o)	chemical-specific	mg/kg-day
Averaging Time, Noncarcinogens (AT_{nc})	1	yr

SSTL Equations

Carcinogenic:

$$SSTL_{ing-c} = \frac{(TR)(BW)(AT_c)(365 day/year)}{(SF_o)(IR_w)(EF)(ED)(ET)(CF)}$$

Noncarcinogenic:

$$SSTL_{ing-nc} = \frac{(THQ)(BW)(RfD_o)(AT_{nc})(365 day/year)}{(IR_w)(EF)(ED)(ET)(CF)}$$

Contaminant	CAS Number[c]	SF_o $(mg/kg\text{-}day)^{-1}$	RfD_o (mg/kg-day)	$SSTL_{ing-c}$ (µg/L)	$SSTL_{ing-nc}$ (µg/L)	$SSTL_{ing}$ (µg/L)
Volatile Organic Compounds						
Benzene	71-43-2	2.90E-02	3.00E-03	1.34E+05	1.67E+05	1.34E+05

[a] µg/L = microgram per liter

[b] mg/kg-day = milligram per kilogram-day

[c] CAS = Chemical Abstracts Service number.

[d] -- = toxicity data not available.

SITE-SPECIFIC TARGET LEVEL CALCULATION[illegible]SED ON INCIDENTAL INGESTION OF GROUNDWATER
INDUSTRIAL LAND USE - CONSTRUCTION SCENARIO - CT SCENARIO
BUILDING 4522
SEYMOUR JOHNSON AFB, NORTH CAROLINA

Exposure Assumptions		
Receptor	Construction Worker:	CT Scenario
Site-specific target level based on incidental ingestion of groundwater ($SSTL_{ing}$)	chemical-specific	µg/L [a]
Target cancer risk level (TR)	1.00E-06	unitless
Body Weight (BW)	70	kg
Averaging Time, Carcinogens (AT_c)	70	yrs
Oral Slope Factor (SF_o)	chemical-specific	$(mg/kg\text{-}day)^{-1}$ [b]
Water Ingestion Rate (IR_w)	0.0025	L/hr
Exposure Frequency (EF)	15	days/yr
Exposure Duration (ED)	1	yr
Exposure Time (ET)	1	hr/day
Conversion Factor (CF)	0.001	mg/µg
Target hazard quotient (THQ)	1	unitless
Oral Reference Dose (RfD_o)	chemical-specific	mg/kg-day
Averaging Time, Noncarcinogens (AT_{nc})	1	yr

SSTL Equations

Carcinogenic:

$$SSTL_{ing-c} = \frac{(TR)(BW)(AT_c)(365 day/year)}{(SF_o)(IR_w)(EF)(ED)(ET)(CF)}$$

Noncarcinogenic:

$$SSTL_{ing-nc} = \frac{(THQ)(BW)(RfD_o)(AT_{nc})(365 day/year)}{(IR_w)(EF)(ED)(ET)(CF)}$$

Contaminant	CAS Number[c]	SF_o $(mg/kg\text{-}day)^{-1}$	RfD_o (mg/kg-day)	$SSTL_{ing-c}$ (µg/L)	$SSTL_{ing-nc}$ (µg/L)	$SSTL_{ing}$ (µg/L)
Volatile Organic Compounds						
Benzene	71-43-2	2.90E-02	3.00E-03	1.64E+06	2.04E+06	1.64E+06

[a] µg/L = microgram per liter

[b] mg/kg-day = milligram per kilogram-day

[c] CAS = Chemical Abstracts Service number.

[d] -- = toxicity data not available.

SITE-SPECIFIC TARGET LEVEL CALCULATIONS BASED ON DERMAL CONTACT WITH GROUNDWATER
INDUSTRIAL LAND USE - CONSTRUCTION SCENARIO - RME SCENARIO
BUILDING 4522
SEYMOUR JOHNSON AFB, NORTH CAROLINA

Input Parameters		
Receptor	Construction Worker:	RME Scenario
Site-specific target level based on dermal contact with groundwater ($SSTL_{derm}$)	chemical-specific	µg/L [a]
Dose absorbed per unit area per event (DA_{event})	chemical-specific	mg/cm^2-event [b]
Conversion Factor (CF)	1.00E+06	(ml/L) x (µg/mg) [c]
Permeability coefficient from water (K_p)	Chemical-specific	cm/hr [d]
Duration of event (t_{event})	2	hr/event [e]
Time it takes to reach steady state (t*)	Chemical-specific	hr/event
Lag time per event (τ_{event})	Chemical-specific	hr/event
Relative contribution of permeability coefficients in strateium corneum and viable epidermis (B)	Chemical-specific	unitless

SSTL Equations

For inorganics:

$$SSTL_{derm-inorg} = \frac{(DA_{event})(CF)}{(K_p)(t_{event})}$$

For organics:

If $t_{event} < t^*$, then:

$$SSTL_{derm-org} = \frac{(DA_{event})(CF)}{2K_p\sqrt{\frac{6\tau_{event}t_{event}}{\pi}}}$$

If $t_{event} > t^*$, then:

$$SSTL_{derm-org} = \frac{(DA_{event})(CF)}{K_p\left[\frac{t_{event}}{1+B} + 2\tau_{event}\left(\frac{1+3B+3B^2}{(1+B)^2}\right)\right]}$$

Contaminant	Type [f]	K_p (cm/hr)	t* (hr/event)	τ_{event} (hr/event)	B (unitless)	DA_{event} (mg/cm^2-event)	$SSTL_{derm-c}$ (µg/L)	$SSTLd_{derm-nc}$ (µg/L)	$SSTL_{derm}$ (µg/L)
Volatile Organic Compounds									
Benzene	o	2.10E-02	6.30E-01	2.60E-01	1.30E-02	2.45E-04		5.86E+03	5.86E+03

[a] µg/L = micrograms per liter
[b] mg/cm^2-event = milligrams per centimeter-event
[c] (ml/L) x (µg/mg) = milliliter per liter times microgram per milligram
[d] cm/hr = centimeters per hour
[e] hr/event = hours per event
[f] "o" indicates an organic compound, "i" indicates an inorganic compound

DA_{event} CALCULATIONS FOR DERMAL CONTACT WITH GROUNDWATER
INDUSTRIAL LAND USE - CONSTRUCTION SCENARIO - RME SCENARIO
BUILDING 4522
SEYMOUR JOHNSON AFB, NORTH CAROLINA

Exposure Assumptions		
Receptor	Construction Worker:	RME Scenario
Dose absorbed per unit area per event (DA_{event})	chemical-specific	mg/cm^2-event [a]
Target cancer risk level (TR)	1.00E-06	unitless
Body Weight (BW)	70	kg
Averaging Time, Carcinogens (AT_c)	70	yrs
Dermal Slope Factor (SF_d) (i.e., SF_o adjusted for GI absorption)	chemical-specific	$(mg/kg\text{-}day)^{-1}$ [b]
Exposure Frequency (EF)	46	days/yr [c]
Exposure Duration (ED)	1	yr
Event Frequency (EV)	1	events/day
Fraction of Estimated Time in Contact with Water (EC)	1	unitless
Exposed Body Surface Area (SA)	5300	cm^2
Target hazard quotient (THQ)	1	unitless
Dermal Reference Dose (RfD_d) (i.e., RfD_o adjusted for GI absorption)	chemical-specific	mg/kg-day
Averaging Time, Noncarcinogens (AT_{nc})	1	yr

SSTL Equations

Carcinogenic:

$$DAevent_{carc} = \frac{(TR)(BW)(AT_c)(365 day/year)}{(SF_d)(EF)(ED)(EV)(EC)(SA)}$$

where $SF_d = \frac{(SF_o)}{(OAF)}$ and: OAF = Oral GI absorption factor (chemical-specific; unitless)

Noncarcinogenic:

$$DAevent_{nc} = \frac{(THQ)(BW)(RfD_d)(AT_{nc})(365 day/year)}{(EF)(ED)(EV)(EC)(SA)}$$

where $RfD_d = (RfD_o)(OAF)$

Contaminant	CAS Number [d]	SF_o $(mg/kg\text{-}day)^{-1}$	RfD_o (mg/kg-day)	OAF (unitless)	SF_d $(mg/kg\text{-}day)^{-1}$	RfD_d (mg/kg-day)	$DAevent_{carc}$ (mg/cm^2-event)	$DAevent_{nc}$ (mg/cm^2-event)	DAevent (mg/cm^2-event)
Volatile Organic Compounds									
Benzene	71-43-2	2.90E-02	3.00E-03	9.70E-01	2.99E-02	2.91E-03	2.45E-04	3.05E-04	2.45E-04

[a] mg/cm^2 = milligram per square centimeter.
[b] mg/kg-day = milligram per kilogram-day
[c] days/yr = days per year
[d] CAS = Chemical Abstracts Service number.
[e] -- = toxicity data not available.

SITE-SPECIFIC TARGET LEVEL CALCULATIONS BASED ON DERMAL CONTACT WITH GROUNDWATER
INDUSTRIAL LAND USE - CONSTRUCTION SCENARIO - CT SCENARIO
BUILDING 4522
SEYMOUR JOHNSON AFB, NORTH CAROLINA

Input Parameters		
Receptor	Construction Worker:	CT Scenario
Site-specific target level based on dermal contact with groundwater ($SSTL_{derm}$)	chemical-specific	μg/L [a]
Dose absorbed per unit area per event (DA_{event})	chemical-specific	mg/cm^2-event [b]
Conversion Factor (CF)	1.00E+06	(ml/L) x (μg/mg) [c]
Permeability coefficient from water (K_p)	Chemical-specific	cm/hr [d]
Duration of event (t_{event})	1	hr/event [e]
Time it takes to reach steady state (t*)	Chemical-specific	hr/event
Lag time per event (τ_{event})	Chemical-specific	hr/event
Relative contribution of permeability coefficients in strateium corneum and viable epidermis (B)	Chemical-specific	unitless

SSTL Equations

For inorganics:

$$SSTL_{derm-inorg} = \frac{(DA_{event})(CF)}{(K_p)(t_{event})}$$

For organics:

If $t_{event} < t^*$, then:

$$SSTL_{derm-org} = \frac{(DA_{event})(CF)}{2K_p\sqrt{\frac{6\tau_{event}t_{event}}{\pi}}}$$

If $t_{event} > t^*$, then:

$$SSTL_{derm-org} = \frac{(DA_{event})(CF)}{K_p\left[\frac{t_{event}}{1+B} + 2\tau_{event}\left(\frac{1+3B+3B^2}{(1+B)^2}\right)\right]}$$

Contaminant	Type [f]	K_p (cm/hr)	t* (hr/event)	τ_{event} (hr/event)	B (unitless)	DA_{event} (mg/cm^2-event)	$SSTL_{derm-c}$ (μg/L)	$SSTLd_{derm-sc}$ (μg/L)	$SSTL_{derm}$ (μg/L)
Volatile Organic Compounds									
Benzene	o	2.10E-02	6.30E-01	2.60E-01	1.30E-02	1.37E-03		4.63E+04	4.63E+04

[a] μg/L = micrograms per liter
[b] mg/cm^2-event = milligrams per centimeter-event
[c] (ml/L) x (μg/mg) = milliliter per liter times microgram per milligram
[d] cm/hr = centimeters per hour
[e] hr/event = hours per event
[f] "o" indicates an organic compound, "i" indicates an inorganic compound

DA_{event} CALCULATIONS FOR DERMAL CONTACT WITH GROUNDWATER
INDUSTRIAL LAND USE - CONSTRUCTION SCENARIO - CT SCENARIO
BUILDING 4522
SEYMOUR JOHNSON AFB, NORTH CAROLINA

Exposure Assumptions		
Receptor	Construction Worker: CT Scenario	
Dose absorbed per unit area per event (DA_{event})	chemical-specific	mg/cm^2-event [a]
Target cancer risk level (TR)	1.00E-06	unitless
Body Weight (BW)	70	kg
Averaging Time, Carcinogens (AT_c)	70	yrs
Dermal Slope Factor (SF_d) (i.e., SF_o adjusted for GI absorption)	chemical-specific	$(mg/kg\text{-}day)^{-1}$ [b]
Exposure Frequency (EF)	15	days/yr [c]
Exposure Duration (ED)	1	yr
Event Frequency (EV)	1	events/day
Fraction of Estimated Time in Contact with Water (EC)	1	unitless
Exposed Body Surface Area (SA)	2910	cm^2
Target hazard quotient (THQ)	1	unitless
Dermal Reference Dose (RfD_d) (i.e., RfD_o adjusted for GI absorption)	chemical-specific	mg/kg-day
Averaging Time, Noncarcinogens (AT_{nc})	1	yr

SSTL Equations

Carcinogenic:

$$DAevent_{carc} = \frac{(TR)(BW)(AT_c)(365 day/year)}{(SF_d)(EF)(ED)(EV)(EC)(SA)}$$

$where\ SF_d = \frac{(SF_o)}{(OAF)}$ and: OAF = Oral GI absorption factor (chemical-specific; unitless)

Noncarcinogenic:

$$DAevent_{nc} = \frac{(THQ)(BW)(RfD_d)(AT_{nc})(365 day/year)}{(EF)(ED)(EV)(EC)(SA)}$$

$where\ RfD_d = (RfD_o)(OAF)$

Contaminant	CAS Number [d]	SF_o $(mg/kg\text{-}day)^{-1}$	RfD_o (mg/kg-day)	OAF (unitless)	SF_d $(mg/kg\text{-}day)^{-1}$	RfD_d (mg/kg-day)	$DAevent_{carc}$ (mg/cm^2-event)	$DAevent_{nc}$ (mg/cm^2-event)	DAevent (mg/cm^2-event)
Volatile Organic Compounds									
Benzene	71-43-2	2.90E-02	3.00E-03	9.70E-01	2.99E-02	2.91E-03	1.37E-03	1.70E-03	1.37E-03

[a] mg/cm^2 = milligram per square centimeter.
[b] mg/kg-day = milligram per kilogram-day
[c] days/yr = days per year
[d] CAS = Chemical Abstracts Service number.
[e] -- = toxicity data not available.

SITE-SPECIFIC TARGET LEVEL CALCULATIONS BASED ON INHALATION OF VOLATILES FROM GROUNDWATER: ABOVEGROUND INDUSTRIAL LAND USE - CONSTRUCTION SCENARIO - RME SCENARIO
BUILDING 4522
SEYMOUR JOHNSON AFB, NORTH CAROLINA

Exposure Assumptions	
Receptor	Construction Worker: RME Scenario
Site-specific target level: aboveground inhalation of volatiles from groundwater ($SSTL_{inh}$)	chemical-specific μg/L [a]
Target cancer risk level (TR)	1.00E-06 unitless
Averaging Time, Carcinogens (AT_c)	70 yrs
Inhalation unit risk factor (URF)	chemical-specific $(\mu g/m^3)^{-1}$ [b]
Exposure Frequency (EF) (180 - 46 days/year = 134 days/year aboveground)	134 days/yr
Exposure Duration (ED)	1 yr
Fraction of time breathing aboveground contaminated air during a 24 hour day (FT) (8 hr/24 hr)	0.3 unitless
Cross-media groundwater-to-ambient (outdoor) air volatilization factor (VF_{wamb})	chemical-specific $(mg/m^3\text{-air})/(mg/L\text{-water})$ [c]
Target hazard quotient (THQ)	1 unitless
Inhalation reference concentration (RfC)	chemical-specific $\mu g/m^3$
Averaging Time, Noncarcinogens (AT_{nc})	1 yr

SSTL Equations

Carcinogenic:

$$SSTL_{inh-c} = \frac{(TR)(AT_c)(365 day/year)}{(URF)(EF)(ED)(FT)(VF_{wamb})}$$

Noncarcinogenic:

$$SSTL_{inh-nc} = \frac{(THQ)(RfC)(AT_{nc})(365 day/year)}{(EF)(ED)(FT)(VF_{wamb})}$$

Contaminant	CAS Number [d]	Chemical Type [e]	URF $(\mu g/m^3)^{-1}$	RfC $(\mu g/m^3)$	VF_{wamb}	$SSTL_{inh-c}$ $(\mu g/L)$	$SSTL_{inh-nc}$ $(\mu g/L)$	$SSTL_{inh}$ $(\mu g/L)$
Volatile Organic Compounds								
Benzene	71-43-2	o	7.80E-06	5.95E+00	4.02E-05	1.82E+06	1.21E+06	1.21E+06

[a] μg/L = microgram per liter

[b] $\mu g/m^3$ = microgram per cubic meter

[c] $(mg/m^3\text{-air})/(mg/L\text{-water})$ = (milligram per cubic meter air) per (milligram per liter water)

[d] CAS = Chemical Abstracts Service number.

[e] "o" = organic; "i" = inorganic

[f] -- = toxicity data not available.

SITE-SPECIFIC TARGET LEVEL CALCULATIONS BASED ON INHALATION OF VOLATILES FROM GROUNDWATER: ABOVEGROUND INDUSTRIAL LAND USE - CONSTRUCTION SCENARIO - RME SCENARIO
BUILDING 4522
SEYMOUR JOHNSON AFB, NORTH CAROLINA

Exposure Assumptions		
Receptor	Construction Worker:	RME Scenario
Site-specific target level: aboveground inhalation of volatiles from groundwater ($SSTL_{inh}$)	chemical-specific	µg/L [a]
Target cancer risk level (TR)	1.00E-06	unitless
Averaging Time, Carcinogens (AT_c)	70	yrs
Inhalation unit risk factor (URF)	chemical-specific	$(\mu g/m^3)^{-1}$ [b]
Exposure Frequency (EF) (60 - 15 days/year = 45 days/year aboveground)	45	days/yr
Exposure Duration (ED)	1	yr
Fraction of time breathing aboveground contaminated air during a 24 hour day (FT) (8 hr/24 hr)	0.3	unitless
Cross-media groundwater-to-ambient (outdoor) air volatilization factor (VF_{wamb})	chemical-specific	$(mg/m^3\text{-air})/(mg/L\text{-water})$ [c]
Target hazard quotient (THQ)	1	unitless
Inhalation reference concentration (RfC)	chemical-specific	$\mu g/m^3$
Averaging Time, Noncarcinogens (AT_{nc})	1	yr

SSTL Equations

Carcinogenic:

$$SSTL_{inh-c} = \frac{(TR)(AT_c)(365 day/year)}{(URF)(EF)(ED)(FT)(VF_{wamb})}$$

Noncarcinogenic:

$$SSTL_{inh-nc} = \frac{(THQ)(RfC)(AT_{nc})(365 day/year)}{(EF)(ED)(FT)(VF_{wamb})}$$

Contaminant	CAS Number [d]	Chemical Type [e]	URF $(\mu g/m^3)^{-1}$	RfC $(\mu g/m^3)$	VF_{wamb}	$SSTL_{inh-c}$ (µg/L)	$SSTL_{inh-nc}$ (µg/L)	$SSTL_{inh}$ (µg/L)
Volatile Organic Compounds								
Benzene	71-43-2	o	7.80E-06	5.95E+00	4.02E-05	5.43E+06	3.60E+06	3.60E+06

[a] µg/L = microgram per liter

[b] $\mu g/m^3$ = microgram per cubic meter

[c] $(mg/m^3\text{-air})/(mg/L\text{-water})$ = (milligram per cubic meter air) per (milligram per liter water)

[d] CAS = Chemical Abstracts Service number.

[e] "o" = organic; "i" = inorganic

[f] -- = toxicity data not available.

CROSS-MEDIA GROUNDWATER-TO-AMBIENT (OUTDOOR) AIR VOLATILIZATION FACTOR
SITE SS-15A
BUILDING 4522

SEYMOUR JOHNSON AFB, NORTH CAROLINA

Equations

Cross-Media Groundwater-to-Ambient (Outdoor) Air Volatilization Factor

$$VF_{wamb} = \frac{H}{1+\left[\frac{U_{air}\delta_{air}L_{GW}}{WD^{eff}_{ws}}\right]} x10^3 \frac{L}{m^3}$$

Effective Diffusion Coefficient Between Ground Water and Soil Surface

$$D^{eff}_{ws} = (h_{cap} + h_v)\left[\frac{h_{cap}}{D^{eff}_{cap}} + \frac{h_v}{D^{eff}_s}\right]^{-1}$$

Effective Diffusion Through Capillary Fringe

$$D^{eff}_{cap} = D^{air}\frac{\theta^{333}_{acap}}{\theta^2_T} + D^{wat}\frac{1}{H}\frac{\theta^{333}_{wcap}}{\theta^2_T}$$

Effective Diffusion Coefficient in Soil Based on Vapor-Phase Concentration

$$D^{eff}_s = D^{air}\frac{\theta^{333}_{as}}{\theta^2_T} + D^{wat}\frac{1}{H}\frac{\theta^{333}_{ws}}{\theta^2_T}$$

	Input Parameter Definition	Input Parameters
VF_{wamb}	Cross-media groundwater-to-ambient (outdoor) air volatilization factor (mg/m^3-air)/(mg/L-water) [a]	Calculated
H	Henry's law constant (cm^3-water)/(cm^3-air) [b]	Chemical-specific
U_{air}	Wind speed above ground surface in ambient mixing zone (cm/s) [c]	447
δ_{air}	Ambient air mixing zone height (cm) [d]	200
L_{GW}	Depth to ground water = h_{cap} + h_v (cm)	152
W	Width of source area parallel to wind, or ground water flow direction (cm)	2700
D^{eff}_{ws}	Effective diffusion coefficient between ground water and soil surface (cm^2/s) [e]	Calculated
h_{cap}	Thickness of capillary fringe (cm)	5
h_v	Thickness of vadose zone (cm)	147
D^{eff}_{cap}	Effective diffusion coefficient through capillary fringe (cm^2/s)	Calculated
D^{eff}_s	Effective diffusion coefficient in soil based on vapor-phase concentration (cm^2/s)	Calculated
D^{air}	Diffusion coefficient in air (cm^2/s)	Chemical-specific
θ_{acap}	Volumetric air content in capillary fringe soils (cm^3-air/cm^3 total volume) [f]	0.038
θ_T	Total soil porosity (cm^3/cm^3-soil) [g]	0.3
θ_{wcap}	Volumetric water content in capillary fringe soils (cm^3-water/cm^3-soil) [h]	0.342
D^{wat}	Diffusion coefficient in water (cm^2/s)	Chemical-specific
θ_{as}	Volumetric air content in vadose zone soils (cm^3-air/cm^3-soil)	0.26
θ_{ws}	Volumetric water content in vadose zone soils (cm^3-water/cm^3-soil)	0.12

Contaminant	H (cm^3-water)/(cm^3-air)	D^{air} (cm^2/s)	D^{wat} (cm^2/s)	D^{eff}_s (cm^2/s)	D^{eff}_{cap} (cm^2/s)	D^{eff}_{ws} (cm^2/s)	VF_{wamb}
Volatile Organic Compounds							
Benzene	2.28E-01	8.80E-02	9.80E-06	1.10E-02	3.16E-05	8.87E-04	4.02E-05

[a] (mg/m^3-air)/(mg/L-water) = milligrams per cubic meter of air per milligrams per liter of water
[b] (cm^3-water)/(cm^3-air) = cubic centimeters of water per cubic centimeters of air
[c] cm/s = centimeters per second
[d] cm = centimeter
[e] cm^2/s = square centimeters per second
[f] cm^3-air/cm^3-total volume = cubic centimeters air per cubic centimeters total volume
[g] cm^3/cm^3-soil = cubic centimeters per cubic centimeters-soil
[h] cm^3-water/cm^3-soil = cubic centimeters water per cubic centimeters soil

SITE-SPECIFIC TARGET LEVEL CALCULATIONS BASED ON INHALATION OF VOLATILES IN TRENCH FROM GROUNDWATER
INDUSTRIAL LAND USE - CONSTRUCTION SCENARIO - RME SCENARIO
BUILDING 4522
SEYMOUR JOHNSON AFB, NORTH CAROLINA

Input Parameters

Receptor	Construction Worker:	RME Scenario
Site-specific target level: inhalation of volatiles in trench from groundwater ($SSTL_{inhal\text{-}trench}$)	chemical-specific	µg/L [a]
Air concentration at target risk/hazard levels (C_{air})	chemical-specific	µg/m³ [b]
Length of side perpendicular to wind (LS)	15	m [c]
Average wind speed (V)	4.47	m/s [d]
Mixing height above water (MH)	2	m
Mass transfer coefficient (K)	Chemical-specific	cm/s [e]
Area of the trench (A)	3.00E+05	cm²
Liquid mass transfer coefficient (K_l)	Chemical-specific	cm/s
Henry's Law Constant (H)	Chemical-specific	atm-m³/mol [f]
Gas mass transfer coefficient (K_g)	Chemical-specific	cm/s
Molecular weight (MW)	Chemical-specific	g/mol
Conversion Factor (CF)	0.001	L/cm³

SSTL Equations

$$SSTL_{inhal-trench} = \frac{(C_{air})(LS)(V)(MH)}{(K)(A)(CF)}$$

where:

$$K = \left[\frac{1}{K_l} + \frac{(8.2E-05\ atm\cdot m^3/mol\cdot{}^\circ K)(298^\circ K)}{(H)(K_g)}\right]^{-1}$$

and:

$$K_l = \left(\frac{32 g/mol}{MW}\right)^{0.5}(0.0061 cm/s)$$

$$K_g = \left(\frac{18 g/mol}{MW}\right)^{0.335}(1.39 cm/s)$$

Contaminant	H (atm-m³/mol)	MW (g/mol)	K_l (cm/s)	K_g (cm/s)	K (cm/s)	C_{air} (µg/m³)	$SSTL_{inhal\text{-}trench}$ (µg/L)
Volatile Organic Compounds							
Benzene	5.56E-03	78.11	3.90E-03	8.50E-01	3.83E-03	2.83E+02	3.31E+04

[a] µg/L = microgram per liter
[b] µg/m³ = microgram per cubic meter
[c] m = meter
[d] m/s = meter per second
[e] cm/s = centimeter per second
[f] atm/m³-mol = atmospher per cubic meter per mole

C_{air} CALCULATIONS BASED ON INHALATION OF VOLATILES FROM GROUNDWATER: TRENCH
INDUSTRIAL LAND USE - CONSTRUCTION SCENARIO - RME SCENARIO
BUILDING 4522
SEYMOUR JOHNSON AFB, NORTH CAROLINA

Exposure Assumptions	
Receptor	Construction Worker: RME Scenario
Air concentration at target risk/hazard levels (C_{air})	chemical-specific $\mu g/m^3$ [a/]
Target cancer risk level (TR)	1.00E-06 unitless
Averaging Time, Carcinogens (AT_c)	70 yrs
Inhalation unit risk factor (URF)	chemical-specific $(\mu g/m^3)^{-1}$
Exposure Frequency (EF)	46 days/yr
Exposure Duration (ED)	1 yr
Fraction of time breathing aboveground contaminated air during a 24 hour day (FT) (assumed 1/2 of work day in trench: 4 hr/24 hr)	0.2 unitless
Target hazard quotient (THQ)	1 unitless
Inhalation reference concentration (RfC)	chemical-specific $\mu g/m^3$
Averaging Time, Noncarcinogens (AT_{nc})	1 yr

C_{air} Equations

Carcinogenic:

$$C_{air-c} = \frac{(TR)(AT_c)(365\ day\ /\ year)}{(URF)(EF)(ED)(FT)}$$

Noncarcinogenic:

$$C_{air-nc} = \frac{(THQ)(RfC)(AT_{nc})(365 day\ /\ year)}{(EF)(ED)(FT)}$$

Contaminant	CAS Number[b/]	Chemical Type[c/]	URF $(\mu g/m^3)^{-1}$	RfC $(\mu g/m^3)$	C_{air-c} $(\mu g/m^3)$	C_{air-nc} $(\mu g/m^3)$	C_{air} $(\mu g/m^3)$
Volatile Organic Compounds							
Benzene	71-43-2	o	7.80E-06	5.95E+00	4.27E+02	2.83E+02	2.83E+02

[a/] $\mu g/m^3$ = microgram per cubic meter

[b/] CAS = Chemical Abstracts Service number.

[c/] "o" = organic; "i" = inorganic

[d/] -- = toxicity data not available.

SITE-SPECIFIC TARGET LEVEL CALCULATIONS BASED ON INHALATION OF VOLATILES IN TRENCH FROM GROUNDWATER
INDUSTRIAL LAND USE - CONSTRUCTION SCENARIO - CT SCENARIO
BUILDING 4522
SEYMOUR JOHNSON AFB, NORTH CAROLINA

Input Parameters		
Receptor	Construction Worker: CT Scenario	
Site-specific target level: inhalation of volatiles in trench from groundwater ($SSTL_{inhal-trench}$)	chemical-specific	µg/L [a]
Air concentration at target risk/hazard levels (C_{air})	chemical-specific	µg/m³ [b]
Length of side perpendicular to wind (LS)	15	m [c]
Average wind speed (V)	4.47	m/s [d]
Mixing height above water (MH)	2	m
Mass transfer coefficient (K)	Chemical-specific	cm/s [e]
Area of the trench (A)	3.00E+05	cm²
Liquid mass transfer coefficient (K_l)	Chemical-specific	cm/s
Henry's Law Constant (H)	Chemical-specific	atm-m³/mol [f]
Gas mass transfer coefficient (K_g)	Chemical-specific	cm/s
Molecular weight (MW)	Chemical-specific	g/mol
Conversion factor (CF)	0.001	L/cm³

SSTL Equations

$$SSTL_{inhal-trench} = \frac{(C_{air})(LS)(V)(MH)}{(K)(A)(CF)}$$

where:

$$K = \left[\frac{1}{K_l} + \frac{(8.2E-05\ atm \cdot m^3/mol \cdot {}^\circ K)(298^\circ K)}{(H)(K_g)}\right]^{-1}$$

and:

$$K_l = \left(\frac{32 g/mol}{MW}\right)^{0.5}(0.0061 cm/s)$$

$$K_g = \left(\frac{18 g/mol}{MW}\right)^{0.335}(1.39 cm/s)$$

Contaminant	H (atm-m³/mol)	MW (g/mol)	K_l (cm/s)	K_g (cm/s)	K (cm/s)	C_{air} (µg/m³)	$SSTL_{inhal-trench}$ (µg/L)
Volatile Organic Compounds							
Benzene	5.56E-03	78.11	3.90E-03	8.50E-01	3.83E-03	8.69E+02	1.01E+05

[a] µg/L = microgram per liter
[b] µg/m³ = microgram per cubic meter
[c] m = meter
[d] m/s = meter per second
[e] cm/s = centimeter per second
[f] atm/m³-mol = atmospher per cubic meter per mole

C_{air} CALCULATIONS BASED ON INHALATION OF VOLATILES FROM GROUNDWATER: TRENCH
INDUSTRIAL LAND USE - CONSTRUCTION SCENARIO - CT SCENARIO
BUILDING 4522
SEYMOUR JOHNSON AFB, NORTH CAROLINA

Exposure Assumptions	
Receptor	Construction Worker: CT Scenario
Air concentration at target risk/hazard levels (C_{air})	chemical-specific $\mu g/m^3$ [a]
Target cancer risk level (TR)	1.00E-06 unitless
Averaging Time, Carcinogens (AT_c)	70 yrs
Inhalation unit risk factor (URF)	chemical-specific $(\mu g/m^3)^{-1}$
Exposure Frequency (EF)	15 days/yr
Exposure Duration (ED)	1 yr
Fraction of time breathing aboveground contaminated air during a 24 hour day (FT) (assumed 1/2 of work day in trench: 4 hr/24 hr)	0.2 unitless
Target hazard quotient (THQ)	1 unitless
Inhalation reference concentration (RfC)	chemical-specific $\mu g/m^3$
Averaging Time, Noncarcinogens (AT_{nc})	1 yr

C_{air} Equations

Carcinogenic:

$$C_{air-c} = \frac{(TR)(AT_c)(365\ day\ /\ year)}{(URF)(EF)(ED)(FT)}$$

Noncarcinogenic:

$$C_{air-nc} = \frac{(THQ)(RfC)(AT_{nc})(365 day\ /\ year)}{(EF)(ED)(FT)}$$

Contaminant	CAS Number [b]	Chemical Type [c]	URF $(\mu g/m^3)^{-1}$	RfC $(\mu g/m^3)$	C_{air-c} $(\mu g/m^3)$	C_{air-nc} $(\mu g/m^3)$	C_{air} $(\mu g/m^3)$
Volatile Organic Compounds							
Benzene	71-43-2	o	7.80E-06	5.95E+00	1.31E+03	8.69E+02	8.69E+02

[a] $\mu g/m^3$ = microgram per cubic meter

[b] CAS = Chemical Abstracts Service number.

[c] "o" = organic; "i" = inorganic

[d] -- = toxicity data not available.

APPENDIX F

BIOSCREEN INPUT AND OUTPUT

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — Version 1.4

Run Name: Keesler AFB SWMU 66

Data Input Instructions:

- 115 → 1. Enter value directly... or
- or 0.02 → 2. Calculate by filling in grey cells below. (To restore formulas, hit button below).
- Variable* → Data used directly in model.
- 20 → Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	86.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	1.1E-02	(cm/sec)
Hydraulic Gradient	i	0.003	(ft/ft)
Porosity	n	0.3	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	43.0	(ft)
Transverse Dispersivity*	alpha y	4.3	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		or	
Estimated Plume Length	Lp	280	(ft)

3. ADSORPTION

Retardation Factor*	R	1.5	(-)
or		or	
Soil Bulk Density	rho	1.7	(kg/l)
Partition Coefficient	Koc	38	(L/kg)
FractionOrganicCarbon	foc	5.7E-5	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	1.3E+0	(per yr)
or		or	
Solute Half-Life	t-half	0.15	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO	0.0784	(mg/L)
Delta Nitrate*	NO3	0.0574	(mg/L)
Observed Ferrous Iron*	Fe2+	2.373	(mg/L)
Delta Sulfate*	SO4	0.252	(mg/L)
Observed Methane*	CH4	0.203	(mg/L)

5. GENERAL

Modeled Area Length*	750	(ft)
Modeled Area Width*	500	(ft)
Simulation Time*	3	(yr)

6. SOURCE DATA

Source Thickness in Sat.Zone* 2 (ft)

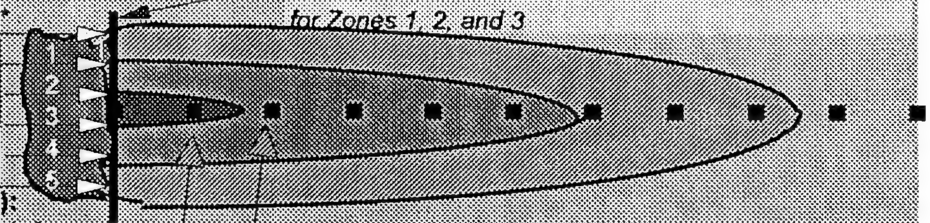
Source Zones:

Width* (ft)	Conc. (mg/L)*
25	5
37.5	13
37.5	14
37.5	13
25	5

Source Halflife (see Help):

Inst. React.	1st Order	
2	2	(yr)

Soluble Mass 8 (Kg)
In Source NAPL, Soil



Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3

View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)			1.3				.006				
Dist. from Source (ft)	0	75	150	225	300	375	450	525	600	675	750

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — View Output

RUN ARRAY — View Output

Help

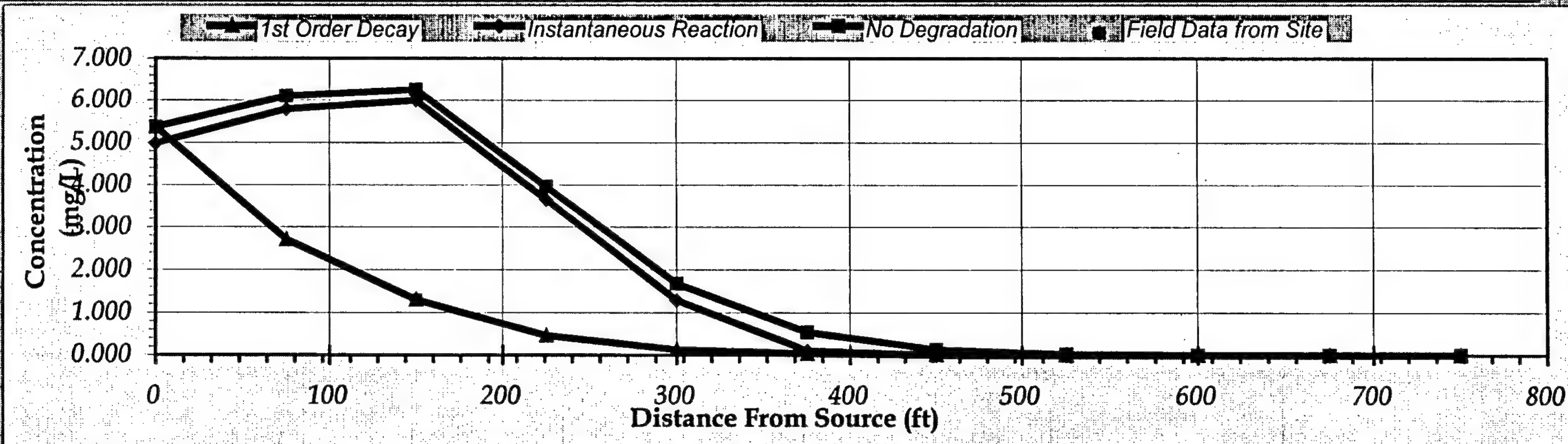
Recalculate This Sheet

Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

TYPE OF MODEL	Distance from Source (ft)										
	0	75	150	225	300	375	450	525	600	675	750
No Degradation	5.370	6.102	6.254	3.963	1.681	0.534	0.125	0.021	0.003	0.000	0.000
1st Order Decay	5.370	2.702	1.303	0.459	0.127	0.030	0.006	0.001	0.000	0.000	0.000
Inst. Reaction	4.987	5.789	6.004	3.653	1.286	0.096	0.000	0.000	0.000	0.000	0.000
Field Data from Site			1.300				0.006				



Calculate Animation

Time: 3 Years

Return to Input

Recalculate This Sheet

BIOSCREEN INSTANTANEOUS REACTION MODEL

Geochemical input data used in this model are described in Appendix F. Using field and laboratory analytical data, background concentrations from wells MW2 and MW5 and concentrations from COPC plume core area wells MPB and MW4 were used to calculate each of the electron acceptors/by-products listed below. Although BTEX compounds dominate the dissolved plumes of gasoline spills, there are non-BTEX hydrocarbons that exert a demand on the available electron acceptors. A conservative approach is to reduce all available electron acceptor/by-product concentrations used in the model by 30 percent to account for the possible impacts of non-BTEX organics in groundwater (Newell *et al.*, 1997). Therefore, the delta for each of the indicators was reduced by 30 percent. Because benzene was the only constituent being modeled and constituted approximately 20 percent of the total BTEX contamination in the Building 4522 groundwater plume, the values were reduced by an additional 80 percent before being input into the model. In summary, only 14 percent of the available electron acceptor capacity was assumed to be available for benzene biodegradation. BIOSCREEN calculates the biodegradation capacities (BCs) for individual parameters. The BC is the amount (in mg/L) of a parameter utilized to biodegrade 1 mg/L of hydrocarbon. The calculated differences are provided below.

Difference in DO

14% [(Avg. Background Oxygen Conc.) - (Minimum Core Oxygen Conc)]

Change in DO = 0.14 * (1.01 mg/L - 0.45 mg/L) = .0784 mg/L

Difference in Nitrate

14% of [(Avg. Background Nitrate Conc.) - (Minimum Core Nitrate Conc.)]

Change in Nitrate = 0.14 * (0.21 mg/L – 0.0 mg/L) = 0.0294 mg/L

Difference in Ferrous Iron

14% of Avg. Core Ferrous Iron Conc.

Ferrous Iron = 0.14 * 16.95 mg/L = 2.373 mg/L

Difference in Sulfate

14% of [(Avg. Background Sulfate Conc.) - (Avg. Core Sulfate Conc.)]

Change in Sulfate = 0.14 * (25.0 mg/L – 23.2 mg/L) = 0.252 mg/L

Difference in Methane

14% of Avg. Core Methane Conc.

Methane = 0.14 * 1.45 mg/L = 0.203 mg/L

APPENDIX G

DATA QUALITY ASSESSMENT REPORT

APPENDIX G
DATA QUALITY ASSESSMENT REPORT
RISK-BASED APPROACH TO REMEDIATION
BUILDING 4522, SEYMOUR JOHNSON AFB, NC

G1.0 INTRODUCTION

An electronic Level III validation of the December 1998 analytical data was performed by Parsons ES and consisted of electronically examining data deliverables to determine data quality. The Level III validation included application of data qualifiers to the analytical results based on adherence to method protocols and project-specific quality assurance/quality control (QA/QC) limits. Method protocols reviewed included:

- analytical holding times,
- method blanks (MBs),
- trip blanks (TBs),
- surrogate spikes,
- matrix spikes/matrix spike duplicates (MS/MSDs),
- laboratory control samples (LCSs), and
- database laboratory flag review.

Data qualifiers were applied to analytical results during the data validation process. All data were validated using method applicable guidelines and in accordance with the *National Functional Guidelines for Organic Data Review* (USEPA, 1994a) and the *National Functional Guidelines for Inorganic Data Review* (USEPA, 1994b).

The following definitions provide explanations of the USEPA (1994a and 1994b) qualifiers assigned to analytical results during data validation. The data qualifiers described were applied to both inorganic and organic results.

U - The analyte was analyzed for and is not present above the reported practical quantitation limit (PQL).

J - The analyte was analyzed for and was positively identified, but the associated numerical value may not be consistent with the amount actually present in the environmental sample. The data should be considered as a basis for decision-making and are usable for many purposes.

R - The data are rejected as unusable for all purposes. The analyte was analyzed for, but the presence or absence of the analyte was not verified. Resampling and reanalysis are necessary to confirm the presence or absence of the analyte.

UJ - The analyte analyzed for was not present above the reported PQL. The associated numerical value may not accurately or precisely represent the concentration necessary to detect the analyte in the sample.

J1 The analyte is qualified as an estimated value solely because it is greater than the method detection limit (MDL) and less than the PQL indicating no laboratory quality issues.

G2.0 DATA QUALITY

Data quality for samples that exceeded QA/QC criteria is summarized in this section. All frequency requirements for field sample collection of QA/QC samples (MS/MSDs and blanks) were met. The frequency requirements for laboratory specific method criteria QA/QC were met overall. In Attachment 1, Tables G1.1 and G1.2 present the sample analytical methods and the samples that were qualified during the validation process, respectively.

G2.1 Surrogate Spikes

Table G2.1 lists all results for target analytes that are out of control with respect to surrogate spike criteria with the percentage of out of control results calculated against the total number of samples collected. Methods SW8260 and SW8310 displayed

TABLE G2.1
OUT-OF-CONTROL SURROGATE SPIKE IMPACT

Anal. Method	Prep. Method	Matrix	Analyte	Flag	# of Qualified Results	Total Number of Samples	Percent of Results Qualified
SW8260	SW5030	SO	1,1,1,2-Tetrachloroethane	UJ	1	3	33%
SW8260	SW5030	SO	1,1,1-Trichloroethane	UJ	1	3	33%
SW8260	SW5030	SO	1,1,2,2-Tetrachloroethane	UJ	1	3	33%
SW8260	SW5030	SO	1,1,2-Trichloroethane	UJ	1	3	33%
SW8260	SW5030	SO	1,1-Dichloroethane	UJ	1	3	33%
SW8260	SW5030	SO	1,1-Dichloroethene	UJ	1	3	33%
SW8260	SW5030	SO	1,1-Dichloropropene	UJ	1	3	33%
SW8260	SW5030	SO	1,2,3-Trichlorobenzene	UJ	1	3	33%
SW8260	SW5030	SO	1,2,3-Trichloropropane	UJ	1	3	33%
SW8260	SW5030	SO	1,2,4-Trichlorobenzene	UJ	1	3	33%
SW8260	SW5030	SO	1,2,4-Trimethylbenzene	J	1	3	33%
SW8260	SW5030	SO	1,2-Dibromo-3-chloropropane	UJ	1	3	33%
SW8260	SW5030	SO	1,2-Dibromoethane (EDB)	UJ	1	3	33%
SW8260	SW5030	SO	1,2-Dichlorobenzene	UJ	1	3	33%
SW8260	SW5030	SO	1,2-Dichloroethane	UJ	1	3	33%
SW8260	SW5030	SO	1,2-Dichloropropane	UJ	1	3	33%
SW8260	SW5030	SO	1,3,5-Trimethylbenzene	J	1	3	33%
SW8260	SW5030	SO	1,3-Dichlorobenzene	UJ	1	3	33%
SW8260	SW5030	SO	1,3-Dichloropropane	UJ	1	3	33%
SW8260	SW5030	SO	1,4-Dichlorobenzene	UJ	1	3	33%
SW8260	SW5030	SO	1-Chlorohexane	UJ	1	3	33%
SW8260	SW5030	SO	2,2-Dichloropropane	UJ	1	3	33%
SW8260	SW5030	SO	2-Chlorotoluene	UJ	1	3	33%
SW8260	SW5030	SO	4-Chlorotoluene	UJ	1	3	33%
SW8260	SW5030	SO	Benzene	UJ	1	3	33%
SW8260	SW5030	SO	Bromobenzene	UJ	1	3	33%
SW8260	SW5030	SO	Bromochloromethane	UJ	1	3	33%
SW8260	SW5030	SO	Bromodichloromethane	UJ	1	3	33%
SW8260	SW5030	SO	Bromoform	UJ	1	3	33%
SW8260	SW5030	SO	Bromomethane	UJ	1	3	33%
SW8260	SW5030	SO	Carbon tetrachloride	UJ	1	3	33%
SW8260	SW5030	SO	Chlorobenzene	UJ	1	3	33%
SW8260	SW5030	SO	Chlorodibromomethane	UJ	1	3	33%
SW8260	SW5030	SO	Chloroethane	UJ	1	3	33%
SW8260	SW5030	SO	Chloroform	UJ	1	3	33%
SW8260	SW5030	SO	Chloromethane	UJ	1	3	33%
SW8260	SW5030	SO	cis-1,2-Dichloroethene	UJ	1	3	33%
SW8260	SW5030	SO	cis-1,3-Dichloropropene	UJ	1	3	33%
SW8260	SW5030	SO	Dibromomethane	UJ	1	3	33%
SW8260	SW5030	SO	Dichlorodifluoromethane	UJ	1	3	33%

TABLE G2.1 (CONTINUED)
OUT-OF-CONTROL SURROGATE SPIKE IMPACT

Anal. Method	Prep. Method	Matrix	Analyte	Flag	# of Qualified Results	Total Number of Samples	Percent of Results Qualified
SW8260	SW5030	SO	Ethylbenzene	J	1	3	33%
SW8260	SW5030	SO	Hexachlorobutadiene	UJ	1	3	33%
SW8260	SW5030	SO	Isopropylbenzene	J	1	3	33%
SW8260	SW5030	SO	m-Xylene & p-Xylene	J	1	3	33%
SW8260	SW5030	SO	Methylene chloride	UJ	1	3	33%
SW8260	SW5030	SO	n-Butylbenzene	J	1	3	33%
SW8260	SW5030	SO	n-Propylbenzene	J	1	3	33%
SW8260	SW5030	SO	Naphthalene	J	1	3	33%
SW8260	SW5030	SO	o-Xylene	J	1	3	33%
SW8260	SW5030	SO	p-Isopropyltoluene	UJ	1	3	33%
SW8260	SW5030	SO	sec-Butylbenzene	J	1	3	33%
SW8260	SW5030	SO	Styrene	UJ	1	3	33%
SW8260	SW5030	SO	tert-Butylbenzene	UJ	1	3	33%
SW8260	SW5030	SO	Tetrachloroethene	UJ	1	3	33%
SW8260	SW5030	SO	Toluene	J	1	3	33%
SW8260	SW5030	SO	trans-1,2-Dichloroethene	UJ	1	3	33%
SW8260	SW5030	SO	trans-1,3-Dichloropropene	UJ	1	3	33%
SW8260	SW5030	SO	Trichloroethene	UJ	1	3	33%
SW8260	SW5030	SO	Trichlorofluoromethane	UJ	1	3	33%
SW8260	SW5030	SO	Vinyl chloride	UJ	1	3	33%
SW8310	SW3510	WG	Acenaphthene	UJ	2	3	67%
SW8310	SW3510	WG	Acenaphthylene	UJ	2	3	67%
SW8310	SW3510	WG	Anthracene	UJ	2	3	67%
SW8310	SW3510	WG	Benzo(a)anthracene	UJ	2	3	67%
SW8310	SW3510	WG	Benzo(a)pyrene	UJ	2	3	67%
SW8310	SW3510	WG	Benzo(b)fluoranthene	UJ	2	3	67%
SW8310	SW3510	WG	Benzo(ghi)perylene	UJ	2	3	67%
SW8310	SW3510	WG	Benzo(k)fluoranthene	UJ	2	3	67%
SW8310	SW3510	WG	Chrysene	UJ	2	3	67%
SW8310	SW3510	WG	Dibenzo(a,h)anthracene	UJ	2	3	67%
SW8310	SW3510	WG	Fluoranthene	UJ	2	3	67%
SW8310	SW3510	WG	Fluorene	UJ	2	3	67%
SW8310	SW3510	WG	Indeno(1,2,3-cd)pyrene	UJ	2	3	67%
SW8310	SW3510	WG	Naphthalene	J	2	3	67%
SW8310	SW3510	WG	Phenanthrene	UJ	2	3	67%
SW8310	SW3510	WG	Pyrene	UJ	2	3	67%

surrogate recovery problems. The concentrations of target compounds in the qualified samples were high and required diluting. As a result, the surrogate concentrations were diluted to less than detectable concentrations and surrogate recoveries could not be determined. All results were qualified as estimated.

G2.2 Matrix Spikes/Matrix Spike Duplicates

MS/MSD validation flags were applied only to the parent sample from a non-compliant MS/MSD. Sample results were not qualified on an analytical batch basis. Table G2.2 lists all results for target compounds that are out of control with respect to MS/MSD criteria with the percentage of out-of-control results calculated against the total number of samples collected. For methods SW8260 and SW8320, the concentrations of target compounds in the qualified samples were high and required diluting. As a result, the matrix spike concentrations were diluted to less than detectable concentrations and matrix spike recoveries could not be determined. All results were qualified as estimated. For method SW625, the benzidine recovery was 0%. Therefore, the sample was rejected.

G2.3 Field Blanks

Table G2.3 lists all results for target compounds that are out of control due to field blank contamination with the percentage of out-of-control results calculated against the total number of samples collected. Methylene chloride was the only contaminant detected. A contaminated trip blank resulted in one sample qualification.

TABLE G2.2
OUT-OF-CONTROL MS/MSD IMPACT

Anal. Method	Prep. Method	Matrix	Analyte	Flag	# of Qualified Results	Total Number of Samples	Percent of Results Qualified
E625	SW3520	WG	3,3'-Dichlorobenzidine	UJ	1	3	33%
E625	SW3520	WG	Benzidine	R	1	3	33%
E625	SW3520	WG	Hexachlorocyclopentadiene	UJ	1	3	33%
SW8260	SW5030	SO	1,1-Dichloroethene	UJ	1	3	33%
SW8260	SW5030	SO	Bromomethane	UJ	1	3	33%
SW8260	SW5030	SO	Dichlorodifluoromethane	UJ	1	3	33%
SW8260	SW5030	SO	Trichlorofluoromethane	UJ	1	3	33%
SW8260	SW5030	SO	Vinyl chloride	UJ	1	3	33%
SW8310	SW3510	WG	Acenaphthene	UJ	1	3	33%
SW8310	SW3510	WG	Acenaphthylene	UJ	1	3	33%
SW8310	SW3510	WG	Anthracene	UJ	1	3	33%
SW8310	SW3510	WG	Benzo(a)anthracene	UJ	1	3	33%
SW8310	SW3510	WG	Benzo(a)pyrene	UJ	1	3	33%
SW8310	SW3510	WG	Benzo(b)fluoranthene	UJ	1	3	33%
SW8310	SW3510	WG	Benzo(ghi)perylene	UJ	1	3	33%
SW8310	SW3510	WG	Benzo(k)fluoranthene	UJ	1	3	33%
SW8310	SW3510	WG	Chrysene	UJ	1	3	33%
SW8310	SW3510	WG	Dibenzo(a,h)anthracene	UJ	1	3	33%
SW8310	SW3510	WG	Fluoranthene	UJ	1	3	33%
SW8310	SW3510	WG	Fluorene	UJ	1	3	33%
SW8310	SW3510	WG	Indeno(1,2,3-cd)pyrene	UJ	1	3	33%
SW8310	SW3510	WG	Naphthalene	J	1	3	33%
SW8310	SW3510	WG	Phenanthrene	UJ	1	3	33%
SW8310	SW3510	WG	Pyrene	UJ	1	3	33%
SW9056	NONE	WG	Nitrate	UJ	1	4	25%

TABLE G2.3
OUT-OF-CONTROL FIELD BLANK IMPACT

Anal. Method	Prep. Method	Matrix	Analyte	Flag	# of Qualified Results	Total Number of Samples	Percent of Results Qualified
SW8260	SW5030	SO	Methylene chloride	U	1	3	33%

G2.4 Method Blanks

Table G2.4 lists all results for target compounds that are out of control due to method blank contamination with the percentage of out-of-control results calculated

against the total number of samples collected. Toluene and methane were the only contaminants detected.

TABLE G2.4
OUT-OF-CONTROL METHOD BLANK IMPACT

Anal. Method	Prep. Method	Matrix	Analyte	Flag	# of Qualified Results	Total Number of Samples	Percent of Results Qualified
E602	SW5030	WG	Toluene	U	1	10	10%
RSK175	METHOD	WG	Methane	U	1	6	17%

G2.5 Laboratory Control Samples

Table G2.5 lists all results for target analytes that are out of control with respect to laboratory control sample (LCS) spike criteria with the percentage of out of control results calculated against the total number of samples collected. Methods SW8260 and E625 displayed LCS recovery problems. All out-of-control recoveries were low with 3,3'-dichlorobenzidine and benzidine recovered at 0%. A low bias is probable in the sample results for these compounds.

TABLE G2.5
OUT-OF-CONTROL LABORATORY CONTROL SAMPLE IMPACT

Anal. Method	Prep. Method	Matrix	Analyte	Flag	# of Qualified Results	Total Number of Samples	Percent of Results Qualified
E625	SW3520	WG	3,3'-Dichlorobenzidine	R	3	3	100%
E625	SW3520	WG	Benzidine	R	3	3	100%
E625	SW3520	WG	N-Nitrosodiphenylamine	UJ	3	3	100%
SW8260	SW5030	SO	Bromomethane	UJ	3	3	100%
SW8260	SW5030	SO	Dichlorodifluoromethane	UJ	3	3	100%

G2.6 Hardcopy Data Review

A review of the hardcopy data for one sample delivery group, revealed no additional analytical problems other than those noted in the preceding paragraphs.

G3.0 CONCLUSIONS

Samples were collected and analyzed as specified in the methods with exception of those issues discussed in this report. All samples are representative of the site and comparable with previous and future investigations when used in accordance with the validation qualifiers. All sample results qualified as "UJ or J" represent an association to non-compliant QC criteria which has caused the reported concentration to be estimated. Project objectives do not exclude the use of estimated concentrations. Although some data was rejected based on the validation (3,3'-dichlorobenzidine and benzidine), the completeness goals of 90 percent were met for all other compounds. Therefore, all data (except those qualified as "R") are usable for the purposes intended.

G4.0 REFERENCES

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USEPA. 1993. Data Quality Objectives Process for Superfund. EPA 540-R-93-071. Washington, DC. September, 1993.

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ATTACHMENT 1

VALIDATED SAMPLES AND QUALIFIED ANALYTICAL RESULTS

VALIDATED SAMPLES AND QUALIFIED ANALYTICAL RESULTS

Tables 1-1 and 1-2 list all qualified sample data based on the results of data validation. The following definitions of column headers will aid in the understanding and use of these tables.

LOCID: Sample location identifier, unique to each sample when used in conjunction of columns SBD and SED.

MX: Sample matrix identifier. "SO" is soil, "WG" is water.

SA: Sample analysis identifier. "N" is for primary field samples, "FR" is for field replicate samples. "N1" or "FR1" designates that the results associate to the original sample analysis. "N8" or "FR8" designates that the results associate to a composite of sample analysis results.

SBD: Sample beginning depth.

SED: Sample ending depth.

COMPOUND NAME: This column identifies the target compound name.

VQ: This column designates if a target compound was detected or not. An "=" denotes a detection above the project PQL. A "ND" denotes a non-detection above the MDL. A "TR" denotes a detection above the MDL but below the project PQL.

PARVAL: This is the concentration of detection for all detected sample results (TR or =). A zero is a placeholder, which associates to a non-detected compound. The zero does not imply that the compound was not detected at less than zero.

LABDL: This is the concentration at which the laboratory reports the project reporting limit. The project reporting limit is a PQL in that it is related to a multiplier of the MDL.

ANMCODE: Analytical method code identifier.

EXMCODE: Analytical extraction method code identifier.

Q: This column represents the final validation qualifier applied to the sample result. It is a composite of all the validation qualifiers for that sample result.

The following column headers apply to the method criteria that are included in data validation. All of the columns may not appear in Table 1-2. Only those method criteria that result in qualifying sample results are listed.

FB	Field Blank
CR	Laboratory Control Sample
HTM	Holding Time
MBM	Method Blank
TBM	Trip Blank
EBM	Equipment Blank
ABM	Ambient Blank
MSRM	MS/MSD (%Recovery/Accuracy)
MSPM	MS/MSD (%RPD/Precision)
LCRM	LCS (%Recovery/Accuracy)
LCPM	LCS (%RPD/Precision)
SURM	Surrogate
TMPM	Temperature
PRSM	Preservation

TABLE G1.1
ANALYTICAL METHODS BY SAMPLE LOCATION

LOCID	SBD	SED	MATRIX	E160_3	E602	E625	RSK175	SW8260	SW8270	SW8310	SW9056	SW9060
98SJMPA	0	0	WG		X							
98SJMPB	0	0	WG		X	X	X			X	X	
98SJMW2	0	0	WG		X		X				X	
98SJMW4	0	0	WG		X	X	X			X	X	
98SJMW5	0	0	WG		X	X	X			X	X	
98SJMW6	0	0	WG		X							
98SJMW7	0	0	WG		X							
98SJMW8	0	0	WG		X							
98SJSB1-2	2	3	SO	X				X				
98SJSB1-4	4	5	SO	X					X			
98SJSB2-3	3	4	SO	X					X			
98SJSB2-4	4	5	SO	X				X				
98SJSB3-4	4	5	SO	X					X			
98SJSB3-5	5	6	SO	X				X				
98SJSB4-5	5	6	SO									X
98SJSB5-3	3	4	SO									X
98SJSW1	0	0	WG		X							
98SJSW2	0	0	WG		X							

TABLE G1.2
QUALIFIED ANALYTICAL RESULTS

LOCID	SBD	SED	MATRIX	SACODE	ANMCODE	EXMCODE	COMPD_NAME	PARVQ	PARVAL	LABDL	UTMCODE	Final Q	FBM	LCRM	MBM	MSRM	SURM
98SJMPB	0	0	WG	N1	E625	SW3520	3,3'-Dichlorobenzidine	ND	0	50	UG/L	R		R		UJ	
98SJMPB	0	0	WG	N1	E625	SW3520	Benzidine	ND	0	100	UG/L	R		R		R	
98SJMPB	0	0	WG	N1	E625	SW3520	Hexachlorocyclopentadiene	ND	0	50	UG/L	UJ				UJ	
98SJMPB	0	0	WG	N1	E625	SW3520	N-Nitrosodiphenylamine	ND	0	10	UG/L	UJ		UJ			
98SJMPB	0	0	WG	N1	SW8310	SW3510	Acenaphthene	ND	0	5	UG/L	UJ					UJ
98SJMPB	0	0	WG	N1	SW8310	SW3510	Acenaphthylene	ND	0	5	UG/L	UJ					UJ
98SJMPB	0	0	WG	N1	SW8310	SW3510	Anthracene	ND	0	0.5	UG/L	UJ					UJ
98SJMPB	0	0	WG	N1	SW8310	SW3510	Benzo(a)anthracene	ND	0	0.65	UG/L	UJ					UJ
98SJMPB	0	0	WG	N1	SW8310	SW3510	Benzo(a)pyrene	ND	0	1.2	UG/L	UJ					UJ
98SJMPB	0	0	WG	N1	SW8310	SW3510	Benzo(b)fluoranthene	ND	0	0.9	UG/L	UJ					UJ
98SJMPB	0	0	WG	N1	SW8310	SW3510	Benzo(ghi)perylene	ND	0	1	UG/L	UJ					UJ
98SJMPB	0	0	WG	N1	SW8310	SW3510	Benzo(k)fluoranthene	ND	0	0.85	UG/L	UJ					UJ
98SJMPB	0	0	WG	N1	SW8310	SW3510	Chrysene	ND	0	1	UG/L	UJ					UJ
98SJMPB	0	0	WG	N1	SW8310	SW3510	Dibenzo(a,h)anthracene	ND	0	1.5	UG/L	UJ					UJ
98SJMPB	0	0	WG	N1	SW8310	SW3510	Fluoranthene	ND	0	1	UG/L	UJ					UJ
98SJMPB	0	0	WG	N1	SW8310	SW3510	Fluorene	ND	0	1	UG/L	UJ					UJ
98SJMPB	0	0	WG	N1	SW8310	SW3510	Indeno(1,2,3-cd)pyrene	ND	0	2.2	UG/L	UJ					UJ
98SJMPB	0	0	WG	N1	SW8310	SW3510	Naphthalene	=	190	5	UG/L	J					J
98SJMPB	0	0	WG	N1	SW8310	SW3510	Phenanthrene	ND	0	1	UG/L	UJ					UJ
98SJMPB	0	0	WG	N1	SW8310	SW3510	Pyrene	ND	0	1	UG/L	UJ					UJ
98SJMPB	0	0	WG	N1	SW9056	NONE	Nitrate	ND	0	1	MG/L	UJ				UJ	
98SJMW4	0	0	WG	N1	E625	SW3520	3,3'-Dichlorobenzidine	ND	0	50	UG/L	R		R			
98SJMW4	0	0	WG	N1	E625	SW3520	Benzidine	ND	0	100	UG/L	R		R			
98SJMW4	0	0	WG	N1	E625	SW3520	N-Nitrosodiphenylamine	ND	0	10	UG/L	UJ		UJ			
98SJMW4	0	0	WG	N1	SW8310	SW3510	Acenaphthene	ND	0	5	UG/L	UJ				UJ	UJ
98SJMW4	0	0	WG	N1	SW8310	SW3510	Acenaphthylene	ND	0	5	UG/L	UJ				UJ	UJ
98SJMW4	0	0	WG	N1	SW8310	SW3510	Anthracene	ND	0	0.5	UG/L	UJ				UJ	UJ
98SJMW4	0	0	WG	N1	SW8310	SW3510	Benzo(a)anthracene	ND	0	0.65	UG/L	UJ				UJ	UJ
98SJMW4	0	0	WG	N1	SW8310	SW3510	Benzo(a)pyrene	ND	0	1.2	UG/L	UJ				UJ	UJ
98SJMW4	0	0	WG	N1	SW8310	SW3510	Benzo(b)fluoranthene	ND	0	0.9	UG/L	UJ				UJ	UJ
98SJMW4	0	0	WG	N1	SW8310	SW3510	Benzo(ghi)perylene	ND	0	1	UG/L	UJ				UJ	UJ
98SJMW4	0	0	WG	N1	SW8310	SW3510	Benzo(k)fluoranthene	ND	0	0.85	UG/L	UJ				UJ	UJ
98SJMW4	0	0	WG	N1	SW8310	SW3510	Chrysene	ND	0	1	UG/L	UJ				UJ	UJ
98SJMW4	0	0	WG	N1	SW8310	SW3510	Dibenzo(a,h)anthracene	ND	0	1.5	UG/L	UJ				UJ	UJ
98SJMW4	0	0	WG	N1	SW8310	SW3510	Fluoranthene	ND	0	1	UG/L	UJ				UJ	UJ
98SJMW4	0	0	WG	N1	SW8310	SW3510	Fluorene	ND	0	1	UG/L	UJ				UJ	UJ
98SJMW4	0	0	WG	N1	SW8310	SW3510	Indeno(1,2,3-cd)pyrene	ND	0	2.2	UG/L	UJ				UJ	UJ
98SJMW4	0	0	WG	N1	SW8310	SW3510	Naphthalene	=	210	5	UG/L	J				J	J
98SJMW4	0	0	WG	N1	SW8310	SW3510	Phenanthrene	ND	0	1	UG/L	UJ				UJ	UJ
98SJMW4	0	0	WG	N1	SW8310	SW3510	Pyrene	ND	0	1	UG/L	UJ				UJ	UJ
98SJMW5	0	0	WG	N1	E625	SW3520	3,3'-Dichlorobenzidine	ND	0	50	UG/L	R		R			
98SJMW5	0	0	WG	N1	E625	SW3520	Benzidine	ND	0	100	UG/L	R		R			
98SJMW5	0	0	WG	N1	E625	SW3520	N-Nitrosodiphenylamine	ND	0	10	UG/L	UJ		UJ			
98SJMW5	0	0	WG	N1	RSK175	METHOD	Methane	TR	0.31	0.5	UG/L	U			U		

TABLE G1.2 (Continued)
QUALIFIED ANALYTICAL RESULTS

LOCID	SBD	SED	MATRIX	SACODE	ANMCODE	EXMCODE	COMPD_NAME	PARVQ	PARVAL	LABDL	UTMCODE	Final Q	FBM	LCRM	MBM	MSRM	SURM
98SJMW8	0	0	WG	N1	E602	SW5030	Toluene	TR	0.29	0.5	UG/L	U			U		
98SJSB1-2	2	3	SO	N1	SW8260	SW5030	1,1-Dichloroethene	ND	0	1.7	MG/KG	UJ				UJ	
98SJSB1-2	2	3	SO	N1	SW8260	SW5030	Bromomethane	ND	0	1.4	MG/KG	UJ		UJ		UJ	
98SJSB1-2	2	3	SO	N1	SW8260	SW5030	Dichlorodifluoromethane	ND	0	1.4	MG/KG	UJ		UJ		UJ	
98SJSB1-2	2	3	SO	N1	SW8260	SW5030	Methylene chloride	TR	0.42	1.4	MG/KG	U	U				
98SJSB1-2	2	3	SO	N1	SW8260	SW5030	Trichlorofluoromethane	ND	0	1.1	MG/KG	UJ				UJ	
98SJSB1-2	2	3	SO	N1	SW8260	SW5030	Vinyl chloride	ND	0	2.5	MG/KG	UJ				UJ	
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	1,1,1,2-Tetrachloroethane	ND	0	3.4	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	1,1,1-Trichloroethane	ND	0	4.6	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	1,1,2,2-Tetrachloroethane	ND	0	2.3	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	1,1,2-Trichloroethane	ND	0	5.7	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	1,1-Dichloroethane	ND	0	2.3	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	1,1-Dichloroethene	ND	0	6.9	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	1,1-Dichloropropene	ND	0	5.7	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	1,2,3-Trichlorobenzene	ND	0	2.3	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	1,2,3-Trichloropropane	ND	0	23	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	1,2,4-Trichlorobenzene	ND	0	2.3	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	1,2,4-Trimethylbenzene	=	52	8	MG/KG	J					J
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	,2-Dibromo-3-chloropropane (	ND	0	11	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	1,2-Dibromoethane (EDB)	ND	0	3.4	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	1,2-Dichlorobenzene	ND	0	2.3	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	1,2-Dichloroethane	ND	0	3.4	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	1,2-Dichloropropane	ND	0	2.3	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	1,3,5-Trimethylbenzene	=	25	3.4	MG/KG	J					J
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	1,3-Dichlorobenzene	ND	0	6.9	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	1,3-Dichloropropane	ND	0	2.3	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	1,4-Dichlorobenzene	ND	0	2.3	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	1-Chlorohexane	ND	0	3.4	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	2,2-Dichloropropane	ND	0	23	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	2-Chlorotoluene	ND	0	2.3	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	4-Chlorotoluene	ND	0	3.4	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	Benzene	ND	0	2.3	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	Bromobenzene	ND	0	2.3	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	Bromochloromethane	ND	0	2.3	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	Bromodichloromethane	ND	0	4.6	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	Bromoform	ND	0	6.9	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	Bromomethane	ND	0	5.7	MG/KG	UJ		UJ			UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	Carbon tetrachloride	ND	0	11	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	Chlorobenzene	ND	0	2.3	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	Chlorodibromomethane	ND	0	3.4	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	Chloroethane	ND	0	5.7	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	Chloroform	ND	0	2.3	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	Chloromethane	ND	0	8	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	cis-1,2-Dichloroethene	ND	0	6.9	MG/KG	UJ					UJ

TABLE G1.2 (Continued)
QUALIFIED ANALYTICAL RESULTS

LOCID	SBD	SED	MATRIX	SACODE	ANMCODE	EXMCODE	COMPD_NAME	PARVQ	PARVAL	LABDL	UTMCODE	Final Q	FBM	LCRM	MBM	MSRM	SURM
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	cis-1,3-Dichloropropene	ND	0	5.7	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	Dibromomethane	ND	0	11	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	Dichlorodifluoromethane	ND	0	5.7	MG/KG	UJ		UJ			UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	Ethylbenzene	=	6.4	3.4	MG/KG	J					J
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	Hexachlorobutadiene	ND	0	5.7	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	Isopropylbenzene	TR	3.5	9.2	MG/KG	J					J
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	m-Xylene & p-Xylene	=	25	3.4	MG/KG	J					J
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	Methylene chloride	ND	0	5.7	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	n-Butylbenzene	=	13	5.7	MG/KG	J					J
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	n-Propylbenzene	=	6.2	2.3	MG/KG	J					J
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	Naphthalene	=	20	5.7	MG/KG	J					J
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	o-Xylene	=	6.1	5.7	MG/KG	J					J
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	p-Isopropyltoluene	ND	0	6.9	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	sec-Butylbenzene	TR	6.8	8	MG/KG	J					J
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	Styrene	ND	0	2.3	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	tert-Butylbenzene	ND	0	8	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	Tetrachloroethene	ND	0	8	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	Toluene	TR	2.1	5.7	MG/KG	J					J
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	trans-1,2-Dichloroethene	ND	0	3.4	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	trans-1,3-Dichloropropene	ND	0	5.7	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	Trichloroethene	ND	0	11	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	Trichlorofluoromethane	ND	0	4.6	MG/KG	UJ					UJ
98SJSB2-4	4	5	SO	N1	SW8260	SW5030	Vinyl chloride	ND	0	10	MG/KG	UJ					UJ
98SJSB3-5	5	6	SO	N1	SW8260	SW5030	Bromomethane	ND	0	0.28	MG/KG	UJ		UJ			
98SJSB3-5	5	6	SO	N1	SW8260	SW5030	Dichlorodifluoromethane	ND	0	0.28	MG/KG	UJ		UJ			